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NFPA 414 Aircraft Rescue and Fire Fighting Vehicles 1990 Edition

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There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 414

Standard for

Aircraft Rescue and Fire Fighting Vehicles

1990 Edition

This edition of NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*, was prepared by the Technical Committee on Aircraft Rescue and Fire Fighting, released by the Correlating Committee on Aviation, and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 21-24, 1990 in San Antonio, TX. It was issued by the Standards Council on July 20, 1990, with an effective date of August 17, 1990, and supersedes all previous editions.

The 1990 edition of this document has been approved by the American National Standards Institute.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Origin and Development of NFPA 414

In 1960 a tentative edition of Parts A and B of this standard was adopted by the Association. In 1961, the Committee recommended official adoption of a revised edition of Parts A and B and submitted a tentative text for Part C to the Annual Meeting, but their recommendation was rejected and the report returned to the sponsoring Committee for further study. During the latter half of 1961 and early 1962, Parts A, B and C were further processed, present Parts F and G added and at the 1962 Annual Meeting, the revised draft was approved by the Association. In 1963 revisions and additions were made to Parts A, B and C; in 1964, old Part D was added; in 1965 and 1967 a number of revisions were made to the text to keep it current; in 1968, the text was re-edited without change in technical content, and in 1969 Part E was added with a number of changes throughout the text. In 1970 a new class of vehicle was added to Part B and a large number of substantive changes were made. Further amendments were made in 1975 and 1978.

In 1984 a complete revision was made to identify three types of vehicles, and to make the document more easily used. The text was rewritten to conform with the Manual of Style and Parts A through E were eliminated.

The standard was revised in 1990, and a chapter was added to provide a test method to verify the design requirements.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Contents

NFPA 414

Standard for

Aircraft Rescue and Fire Fighting Vehicles

1990 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Information on referenced publications can be found in Chapter 6 and Appendix B.

Chapter 1 Administration

1-1 Scope.

1-1.1* This standard specifies the optimum design, performance, and acceptance criteria for aircraft rescue and fire fighting vehicles intended to carry rescue and fire fighting equipment for rescuing occupants and combating fires in aircraft on, or in the vicinity of, an airport.

1-1.2 This standard shall cover 3 types of vehicles: (1) Major Vehicles, (2) Rapid Intervention Vehicles, and (3) Combined Agent Vehicles.

1-1.3 Vehicles that are not wheeled, such as track, amphibious, or air-cushion types, are not covered by this standard.

1-1.4 The design criteria for the standard vehicles described by this document shall consider temperature extremes ranging from 32°F (0°C) to 110°F (43°C). For cold weather operation where temperatures periodically range between −40°F (−40°C) and 32°F (0°C), or colder, some type of winterization system shall be specified by the purchaser.

1-2 Purpose.

1-2.1 The purpose of this standard is to specify features and components that, when assembled, will produce an efficient and capable fire fighting vehicle for both on- and off-pavement performance. Off-pavement capability is important to ensure timely and effective response of these vehicles to aircraft accident sites off paved surfaces. Fire fighting capabilities are considered to be optimum for the proper performance of these vehicles.

1-2.2 It is not the purpose of this standard to serve as a detailed purchase specification. Drafting of complete specifications for bidding purposes is the responsibility of the purchaser.

1-3* Definitions.

AFFF. See Aqueous Film Forming Foam.

Aggressive Tire Tread. Tread designed to provide a maximum of traction for all types of service. This would include sand, mud, snow, ice, and hard surface, wet or dry.

Air-Cooled Engine. One in which the heat given off from the cylinder walls is directly absorbed by the atmosphere rather than the heat being absorbed by a liquid coolant that acts only as a vehicle for transferring the heat from the engine to a radiator.

Air-Mechanical Brakes. Brakes in which the force from an individual air chamber is directly applied to the friction surfaces through a mechanical linkage.

Air Over Hydraulic Brakes. Brakes in which the force of a master air cylinder is applied to the friction surfaces through an intervening hydraulic system.

All-Wheel Drive. A vehicle that drives on all wheels such as (b), (d), and (e) under the definition "Vehicle Types."

Ambient Temperature. The average temperature of the environment surrounding a vehicle.

Angle of Approach. The measure of the steepest ramp that a fully loaded vehicle can approach. It is determined by the horizontal ground line and the line tangent to the loaded radius of the front tire extended forward to that fixed point on the vehicle, which will form the smallest angle.

Angle of Departure. The measure of the steepest ramp from which the fully loaded vehicle can depart. It is determined by the horizontal ground line and the line tangent to the loaded radius of the rear tire extended rearward to that fixed point on the vehicle which will form the smallest angle.

Approved.* Acceptable to the "authority having jurisdiction."

Aqueous Film Forming Foam (AFFF) Concentrate. A concentrated aqueous solution of fluorinated surfactant(s) and foam stabilizers that is capable of producing an aqueous fluorocarbon film on the surface of hydrocarbon fuels to suppress vaporization.

Authority Having Jurisdiction.* The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

Automatic Locking Differential. A type of nonslip differential that operates automatically.

Axle Tread. The distance between the center of 2 tires or wheels on 1 axle. Where dual tires and wheels are used at each end of an axle, the tread is measured as the distance between centers of the pairs of tires or wheels.

Bogie. A combination of 2 axles used to support the end of a vehicle; therefore, in a 6 × 6 vehicle there are 2 axles at the rear of the vehicle to support the weight on the rear. This 2-axle combination is called a "rear bogie." With an 8 × 8 vehicle, there are 2 axles in the front and 2 axles in the rear; therefore, there is a front bogie and a rear bogie.

Center of Gravity. The point within a vehicle at which all of its weight may be considered to be concentrated. When a vehicle is tipped to a degree that a vertical line passing through the center of gravity falls on the ground outside the tire track, it is unstable and will turn over.

Chassis. The assembled frame, engine, drive train, and tires of a vehicle.

Component Manufacturer's Certification. A signed application approval furnished by the component manufacturer certifying that the component in question is either (1) approved as being properly installed and/or applied in the vehicle for its intended use; or (2) in compliance with the respective construction criteria required by the standard.

Cooling Preheater Device. A device for heating the engine coolant so that the engine is maintained at a constant temperature. It usually consists of a coolant jacket and an electric heating element. The engine coolant flows through the preheater jacket and is heated by the heating element which obtains its power from an outside source, thereby holding the engine coolant at a constant temperature for fast starting.

Dry Nitrogen, Dry Air. Dry defines nitrogen or air that has a dew point of -60°F (-15.6°C) or lower.

Fluid Coupling. A turbine-like device that transmits power solely through the action of a fluid in a closed circuit without direct mechanical connection between input and output shafts and without resulting in torque multiplication.

Fluoroprotein-Foam-Concentrate. A protein-foam concentrate incorporating 1 or more fluorochemical surfactants to enhance its tolerance to fuel contamination.

Foam Expansion. This is the ratio between the volume of foam produced and the volume of solution used in its production.

Foam-Liquid Concentrate Percentage. The percentage of foam-liquid concentrate in solution with water.

Fully Loaded Vehicle. The fully loaded vehicle shall consist of the fully assembled vehicle complete with a full compliment of crew, fuel, and fire fighting agents. The crew allowance shall be 175 lb per seating position. Unless otherwise specified, the equipment allowance shall be 250 lb per storage compartment up to a maximum of 1,000 lb. Where the customer specifications require that more equipment be carried, the actual weight of the equipment shall be included.

In-Service Condition. A state or condition of readiness for intended duty. Usually an emergency vehicle properly serviced with all equipment properly loaded and ready for immediate response.

Intended Airport Service.* Includes all aspects of aircraft rescue and fire fighting services, as set forth in this text.

Interaxle Clearance Angle (Ramp Angle). The measure of the ability of a fully loaded vehicle to negotiate a ramp without encountering interference between the vehicle and the ramp between any 2 axles. It shall be determined by the horizontal ground line and whichever of the following lines forms the smaller angle:

(a) The line tangent to the loaded radius of the front tire, extended rearward to that fixed point on the vehicle, ahead of a vertical line midway between the 2 axles, which will determine the smallest angle.

(b) The line tangent to the loaded radius of the rear tire extended forward to that fixed point on the vehicle, behind a vertical line midway between the 2 axles, which will determine the smallest angle.

Interaxle Differential. A differential in the line of drive between any 2 axles.

Lightweight Construction. Intended to indicate the use of nonferrous metals or plastics or a reduction in weight by the use of advanced engineering practices resulting in a weight saving without sacrificing strength or efficiency.

Listed.* Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

May. This term is used to state a permissive use or an alternative method to a specified requirement.

No-Load Condition. An engine with standard accessories operating without an imposed load, with the vehicle drive clutches and any special accessory clutches in a disengaged or neutral condition.

Off-Pavement Performance. The vehicle's ability to perform or operate on other than paved surfaces. This "other than paved surfaces" includes dirt roads and trails and open cross country of all kinds. This ability factor is sometimes referred to as off-road mobility or cross country mobility. All of these terms are synonymous.

Operational Tests. An every vehicle test conducted by the manufacturer to ensure that each vehicle is fully operational when it is delivered and to ensure that the original level of performance of the prototype vehicle has been maintained.

Overall Height, Length, and Width. The dimensions determined with the vehicle fully loaded and equipped unless otherwise specified and shall include all fixed protrusions that could in any way hinder the passage of the vehicle. Dimensions over movable protrusions shall be determined with the protrusion in its normally stored position.

Percent Grade. The ratio of the change in elevation to the horizontal distance traveled multiplied by 100. A change in elevation of 50 ft (15 m) over a horizontal distance of 50 ft (15 m) is the equivalent of a 100 percent grade.

Power-Assist Steering. A system using hydraulic or air power to aid in the steering assist. This system is supplementary to the mechanical system to preserve steering ability in event of power failure.

Protein-Foam Concentrate. A concentrate consisting primarily of products from a protein hydrolysate, plus stabilizing additives and inhibitors to protect against freezing, to prevent corrosion of equipment and containers, to resist bacterial decomposition, to control viscosity, and to otherwise ensure readiness for use under emergency conditions.

Prototype Vehicle. The first vehicle of a unique vehicle configuration built to establish the performance capability, not only of itself, but of all subsequent vehicles manufactured from the same drawings and parts list. A given chassis, body, and fire fighting system and fully loaded weight condition shall constitute a vehicle configuration. Product improvements and customer options shall negate previously conducted prototype tests only if they materially effect a performance factor.

Radio Suppression. Suppression of the ignition and electrical system noises that normally interfere with radio transmission and reception.

Rapid Intervention Vehicle (RIV).* A complimentary vehicle to the major fire fighting vehicles. The design and purpose of the RIV is to provide a means of bringing the extinguishing agent to the aircraft crash scene significantly faster (up to 60 seconds) than can be achieved by major fire fighting vehicles.

Rubber-Gasketed Fitting. A device for providing a leakproof connection between 2 pieces of pipe while allowing moderate movement of 1 pipe relative to the other. It incorporates a rubber seal held in place by a 2-piece clamp that also engages annular grooves near the end of each pipe to prevent pullout under pressure.

Shall. Indicates a mandatory requirement.

Should. This term, as used in Appendix A, indicates a recommendation or that which is advised but not required.

Steering Drive Ends. Steering drive ends or stub shafts are in the front wheel spindle in a driving-steering axle as used at the front of an all-wheel drive vehicle. The universal joint that permits steering while transmitting power is supported by the steering drive end at its inner end, and the outer end is connected to the wheel hub through a driving flange.

Ton. Equals 2,000 lb (907 kg).

Torque Converter. A device similar to the fluid coupling but which, by means of additional turbine blades, results in variable torque multiplication.

Twenty-Five (25) Percent Drainage Time. The time in minutes that it takes for 25 percent of the total liquid contained in the foam collected in a specified manner to drain out. A method of measuring drainage time is given in NFPA 412, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles.*

Under-Body Clearance Dimensions. Dimensions determined with the vehicle fully loaded and fully equipped unless otherwise specified and shall include all components of the vehicle, except those that are part of the axle assemblies, which could hinder the passage of the vehicle.

Unitized Rigid Body and Frame Structure. One in which parts, that generally would comprise a separate body, are integrated with the chassis frame to form one rigid, load-carrying structure.

Unsprung Weight. The total weight of all vehicle components that are not completely supported by the suspension system.

Vehicle Types. Vehicle types are designed as 4 × 2, 4 × 4, 6 × 4, 6 × 6, and 8 × 8. These are used to indicate the number of wheels on the vehicle and the number of wheels that propel or drive the vehicle. The term "wheel" in this designation is interpreted to mean either a single tire or a set of dual tires operating as one tire. The first number is the number of wheels, the second number is the number of driving wheels, therefore:

(a) A 4 × 2 vehicle is one having 4 wheels and drives on 2 wheels.

(b) A 4 × 4 vehicle is one having 4 wheels and drives on all 4 wheels.

(c) A 6 × 4 vehicle is one having 6 wheels and drives on 4 wheels.

(d) A 6 × 6 vehicle is one having 6 wheels and drives on all 6 wheels.

(e) An 8 × 8 vehicle is one having 8 wheels and drives on all 8 wheels.

Wall-to-Wall Turning Diameter. Intended to measure the space that will completely contain a vehicle as it is being turned. It is, therefore, the diameter of the smallest circle that can be described by the outermost point on the vehicle as it negotiates a 360° right or left turn.

Weathertight. Compartment closure sufficient to prevent rain, snow, and wind-driven sand, dirt, or dust from penetrating under all operating conditions. It is not intended to be watertight or submersible.

Weight Scale Measurement. The accurate measurement of vehicle weight by means of a scale to verify or check a stated or estimated weight.

1-4 Requirements for All Aircraft Rescue and Fire Fighting Vehicles — Responsibility of Contractors/Suppliers.

1-4.1* The aircraft rescue and fire fighting vehicle manufacturer shall assume responsibility for design, construction, and performance for all component parts of the complete vehicle, even though major portions may be subcontracted and shall certify that the completed vehicle meets the requirements of this standard.

1-4.2 The manufacturer shall supply at time of delivery at least 2 complete copies of the following manuals:

(a) Operator's Manual

(b) Service Manual

(c) Parts Manual.

These manuals shall cover the complete vehicle and shall be in accordance with the following:

1-4.2.1 Operator's Manual. Operating instructions shall include all information required for operation of the vehicle, vehicle components, fire fighting systems, and integral vehicular options. Location and function of all controls and instruments shall be covered by illustrations and descriptions. These instructions, as a minimum, shall also include the following:

(a) Complete description of the vehicle and special equipment.

(b) Preparation for use of the vehicle upon receipt.

(c) Operator daily maintenance and mission readiness checks.

(d) Periodic operator inspection.

1-4.2.2 Service Manual. The repair and overhaul instructions shall be factual, specific, concise, and clearly worded. The instructions shall cover such typical maintenance and repair operations as troubleshooting, adjustment procedures, minor and major repairs and overhaul, removal and replacement of units, assemblies and subassemblies, and complete instructions for disassembly and reassembly of components. The instructions shall also include data listing tolerances, specifications, and capacities. Illustrations, wiring diagrams, and exploded views shall be used to clarify texts and appear as close to the related text as possible. Special tools required for the repair and overhaul of the equipment shall be listed and illustrated. The service manual shall contain a suitable index.

1-4.2.3 Parts Manual. The parts list shall include illustrations and exploded views necessary for the proper identification of all parts, assemblies, and subassemblies. Assemblies or components shall be shown in illustrations and be identified by reference numbers that correspond to the reference numbers in the parts list. The size, thread dimensions, and special characteristics shall be given on all nonstandard nuts, bolts, washers, grease fittings, and similar items. The parts identification manual shall show the description and quantity of each item used per vehicle. The parts identification manual shall contain a numerical index.

1-4.2.3.1 The vehicle manufacturer shall ensure the purchaser that parts critical to the mission of the vehicle will be shipped within 48 hours. The original equipment manufacturers shall be disclosed to the owner if the vendor is unable to supply the parts required within this time frame to permit local purchase of an equivalent part.

Chapter 2 Major Fire Fighting Vehicles

2-1 General.

2-1.1 The category of major vehicles shall encompass a range of water capacity commencing at 1000 gal (4000 L) and extending to over 3000 gal (12000 L). Because the same performance cannot be expected of all vehicles within this range, vehicles shall be classified into water capacity ranges within which a similar level of performance is practical.

2-1.2 The following vehicles rated in gallons shall establish the class of vehicle:

Class	Minimum Rated Water Capacity Gallons	(Liters)
1	1000	(4000)
2	1500	(6000)
3	2500	(9000)
4	3000 and over	(11000 and over)

2-2 Weights and Dimensions.

2-2.1 Weights.

2-2.1.1 The actual gross vehicle weight of the fully staffed, loaded, and equipped vehicle ready for service shall not exceed the manufacturer's gross vehicle weight rating.

2-2.1.2* The weight shall be distributed as equally as practical over the axles and tires of the fully loaded vehicle. The difference in weight between tires on any axle shall not exceed 5 percent of the average tire weight for that axle. The difference in weight between any 2 axles shall not exceed 10 percent of the weight of the heaviest axle if the heavy axle is a rear axle. If the heavy axle is a front axle, the weight difference between it and any other axle shall not exceed 5 percent of the heavy axle weight. Under no circumstances shall axle and tire manufacturer's rating be exceeded.

2-2.1.3 The center of gravity of the vehicle shall be kept as low as possible under all conditions of loading. Vehicles in Classes 1, 2, 3, and 4 shall be able to stand on sideways slopes of 30°, 28°, 26.5°, and 24° — 58 percent, 53 percent, 50 percent, and 45 percent — respectively.

2-2.1.4 The vehicle shall also be driven on a steering pad around a circle of 100 ft (30 m) radius. The steering wheel rotation shall increase with increasing speed to ensure the vehicle does not exhibit oversteer characteristics. A speed in excess of 22 mph (35 km/h) shall be obtained with vehicles in Classes 1 and 2, and a speed in excess of 18.5 mph (30 km/h) shall be obtained with Class 3 and 4 vehicles.

2-2.2 Dimensions.

2-2.2.1 Clearance of the vehicle shall permit mobility in soft soils and rough terrain with the vehicle's tires inflated to highway inflation pressures. The following shall be minimum dimensions:

Angle of Approach - 30°

Angle of Departure - 30°

Interaxle Clearance Angle - 12°

Underaxle Clearance - 13 in. (330 mm) under axle differential housing bowl.

Under-Body Clearance - 18 in. (458 mm).

2-2.2.2* Overall height, length, and width of the vehicle shall be held to a minimum consistent with the best operational performance of the vehicle and the design concepts needed to achieve this performance and to provide optimum maneuverability and facilitate movement on public highways.

2-2.2.3 The vehicle shall be constructed such that a seated driver, having an eye reference point of 31¾ in. (805 mm) above the seat cushion and 12 in. (30.5 cm) forward from the seat back, shall be able to see the ground 20 ft (6 m) ahead of the vehicle and have vision of at least 5° above the horizontal plane. The vision in the horizontal plane shall be at least 90° on each side from the straight ahead position.

2-2.2.4 Adjustable rear view mirrors with a glass area of not less than 60 sq in. (385 cm^2) shall be provided on each side of the vehicle. Each shall be provided with a minimum of a 7 sq in. area (45.2 cm^2) wide angle convex mirror.

2-3 Engine.

2-3.1 Performance Requirements.

2-3.1.1 The vehicle engines shall have horsepower, torque, and speed characteristics to meet and maintain all specified vehicular performance characteristics specified in this standard. The engine manufacturer shall certify that the installed engine is approved for this application.

2-3.1.2* The fully loaded vehicle shall consistently be able to accelerate from 0-50 mph (0-80 km/h) on dry level concrete pavement at the operational airport within the times specified in Table 2-3.1.2. Maximum speed shall not be less than 65 mph (100 km/h).

Table 2-3.1.2

Class	Minimum Water Capacity U.S. Gallons	(Liters)	Maximum Acceleration Time 0-50 mph (0-80 km/h) in Seconds
1	1000	(4,000)	25
2	1500	(6,000)	30
3	2500	(9,000)	40
4	3000 and over	(11,000 and over)	45

The above acceleration times shall be achieved with the engine and transmission at their normal operating temperatures at any ambient temperature varying from 0°F (−18°C) to 110°F (43°C) and at elevations up to 2,000 ft (600 m) above sea level unless a higher elevation is specified.

Airports above 2,000 ft (600 m) shall state the elevation at which the vehicle will operate in order to ensure the required performance.

2-3.1.3 The vehicle shall also be capable of ascending, stopping, starting, and continued ascent on a 40 percent grade on dry pavement at a speed up to at least 1 mph (1.6 km/h) with extinguishing agents being discharged from the primary turret nozzle(s).

2-3.2 Engine Cooling Systems.

2-3.2.1 Liquid Cooled Engines.

2-3.2.1.1 The cooling system shall be designed so that the stabilized engine coolant temperature remains within the engine manufacturer's prescribed limits under all operational conditions and at all ambient temperatures encountered at the operational airport. The cooling system shall be provided with an automatic thermostat for rapid engine warming.

2-3.2.1.2 Radiator shutters, when furnished for cold climates, shall be of the automatic type and shall be designed to open automatically upon failure.

2-3.2.2 Air-Cooled Engines.

2-3.2.2.1 Air-cooled engines shall be designed so that the stabilized cylinder head and oil temperatures remain within the engine manufacturer's prescribed limits under all operational conditions and at all ambient temperatures encountered at the operational airport.

2-3.3 Fuel System.

2-3.3.1 A complete fuel system requiring engine manufacturer's installation approval shall include a fuel pump, fuel filtration, and flexible fuel lines where necessary that shall be protected from damage, exhaust heat, and exposure to ground fires.

2-3.3.2 Accessible filtration shall be provided for each fuel supply line and a drain shall be provided at the bottom of the fuel tank.

2-3.3.3 Fuel tanks shall not be installed in a manner that permits gravity feed.

2-3.3.4 A minimum 50 gallon fuel tank capacity shall be provided.

2-3.4 Exhaust System.

2-3.4.1 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 system shall be of high grade, rust resistant materials.

2-3.4.2 The exhaust system shall be protected from damage that could result from traversing rough terrain. Tailpipe shall be designed to discharge upward or to the rear and shall not be directed toward the ground.

2-4 Vehicle Electrical System.

2-4.1 The vehicle shall be provided with one of the following electrical systems:

(a) 12 volt electrical and starting

(b) 24 volt electrical and starting

(c) 12 volt electrical/24 volt starting.

2-4.2 The electrical system shall have negative ground including transistorized alternator and a fully transistorized voltage regulator. The alternator shall be rated at 100 percent of anticipated load at 50 percent engine governed speed and if belt driven shall be driven by dual belts.

2-4.2.1 For 12 volt electrical and starting systems, and for 12 volt electrical/24 volt starting systems, the curb idle minimum charging rate of the alternator shall be 50 amp.

2-4.2.2 For 24 volt electrical and starting systems, the curb idle minimum charging rate of the alternator shall be 30 amp.

2-4.3 Batteries shall be securely mounted and adequately protected against physical injury and vibration, water spray, and engine and exhaust heat. When an enclosed battery compartment is provided, it shall be adequately ventilated and the batteries shall be readily accessible for examination, test, and maintenance.

2-4.3.1 For 12 volt systems, there shall be two 12 volt batteries connected in parallel, 200 amp hr capacity each at a 20 hr rate.

2-4.3.2 For 24 volt systems, there shall be two 24 volt batteries, connected in parallel, 100 amp hr capacity each at a 20 hr rate; four 12 volt batteries connected in series parallel, 100 amp hr capacity each at 20 hr a rate; or two 12 volt batteries connected in series at a 200 amp hr capacity each at 20 hr rate.

2-4.4 Battery capacity and wiring circuits provided, including the starter switch and circuit and the starter to battery connections, shall meet or exceed the manufacturer's recommendations. A master battery disconnect switch shall be provided.

2-4.4.1 For 12 volt electrical/24 volt starting systems, there shall be two 12 volt batteries connected in series parallel through a solid state series parallel circuit to accomplish 24 volt starting. The batteries shall have 200 amp hr capacity each at a 20 hr rate.

2-4.5 A built-in battery charger shall be provided on the vehicle to maintain full charge on all batteries. Grounded AC receptacle shall be provided to permit a pull away connection from local electric power supply to battery charger.

2-4.6 An engine coolant preheating device shall be provided as an aid to rapid starting and high initial engine performance.

2-4.7 The electrical system shall be insulated, waterproofed, and protected against exposure from ground fires. All wiring shall be coded in some manner to correspond with the wiring diagram provided with the vehicle. Circuit protection shall be provided to protect the vehicle in the event of electrical overload.

2-4.8 Radio suppression of the electrical system shall be in accordance with SAE J551, *Standard on Performance Levels and Methods of Measurement of Electromagnetic Radiation from Vehicles and Devices (20-1000 MHz)* or an equivalent radio suppression standard.

2-5 Vehicle Drive.

2-5.1 Transmission of power from the engine to the wheels of the vehicle shall be through a torque converter and automatic or semi-automatic gearbox. The entire drive train shall be designed and rated by the component manufacturer as having sufficient capacity to slip the wheels of the static-loaded vehicle on a surface having a coefficient of friction of 0.8. A range of gears providing the specified top speed and a grade ability of 50 percent shall be provided with sufficient intermediate gears to achieve the specified acceleration. The transmission shall be properly matched to the engine and be approved for the application by the transmission manufacturer.

2-5.1.1 A transmission cooling system shall be provided and designed so that the stabilized transmission oil temperature remains within the transmission manufacturer's prescribed limits under all operational conditions and at all ambient temperatures encountered at the operational airport.

2-5.2 The provision of positive drive to each wheel by means of a fully locked driveline shall be required in order to maximize traction on low friction surfaces. Positive drive may be achieved either by the use of automatic locking and torque proportioning differentials or may be manually selectable by the seated driver, while the vehicle is in motion, by use of a single control.

2-5.3 All-wheel drive on these vehicles shall incorporate a drive to the front and rear axles that is engaged at all times during the intended airport service. An interaxle differential shall be installed with automatic or driver selected means of differential locking.

2-5.4 All traction increasing devices shall be operated by a single control for driving simplicity.

2-5.5 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 percent of the tire sectional width at rated load.

2-6 Suspension.

2-6.1 The suspension system shall be designed to permit the loaded vehicle to:

(a) travel at the specified speeds over improved surface;

(b) travel at moderate speeds over unimproved surface;

(c) provide diagonally opposite wheel motion 14 in. (355 mm) above ground obstacles without raising the remaining wheels from the ground;

(d) prevent damage to the vehicle caused by wheel movement; and

(e) provide a good environment for the crew when traveling over all surfaces.

2-7 Rims, Tires, and Wheels.

2-7.1 Vehicles shall be required to have off-highway mobility while meeting the specified paved surface performance.

2-7.2 Tires shall be selected to maximize the acceleration, speed, braking, and maneuvering capabilities of the vehicle on paved surfaces without sacrificing performance on all reasonable terrains found within the airport boundary.

2-7.3* The purchaser shall provide a tire description that reflects the off-road performance requirements necessitated by the soil conditions encountered at the operational airport. Soil conditions that may vary from an extremely fine grain soil or clay to an extremely coarse grain soil, sand, or gravel in a dry, saturated, or frozen condition shall be considered.

To optimize floatation under soft ground conditions, tires of larger diameter or width, or both, than is needed for weight carrying alone shall be specified. Similarly, the lowest tire pressure compatible with the high speed performance requirements shall also be specified.

2-7.4 Vehicle and tire manufacturers shall be consulted for tread design most suitable for specific soil composition at individual airports.

2-7.5 All wheels on the vehicle shall be of the single wheel type with all rims, tires, and wheels of identical size and same tire tread design.

2-7.6 Rims, tires, wheels, and inflation pressures shall be approved by the respective manufacturers as having sufficient capacity to meet the specified performance, and shall be certified for not less than 5 mi (8 km) of continuous operation at 65 mph (100 km/h) at normal operational pressure.

2-8 Towing Connections.

2-8.1 Four large tow eyes or tow hooks capable of towing the vehicle on level ground without damage shall be mounted, 2 at the front and 2 at the rear of the truck, and attached directly to the frame structure. Recovery of the vehicle from adverse conditions shall be made by attaching to the axles.

2-9 Brakes.

2-9.1* The braking system shall feature service, emergency, and parking brake systems. Service brakes shall be power actuation air, hydraulic, or air over hydraulic. Expanding shoe and drum brakes or caliper disc brakes shall be 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 bowl.

2-9.2 Service brakes shall be of the all-wheel type with split circuits so that failure of 1 circuit shall not cause total service brake failure.

2-9.2.1 The service brakes shall be capable of holding the fully loaded vehicle on a 50 percent grade.

2-9.2.2 For Class 1, 2, and 3 vehicles, the service brakes shall stop the vehicle within 35 ft (10.7 m) from 20 mph (32 km/h), and within 131 ft (40 m) from 40 mph (64 km/h).

2-9.2.3 For Class 4 vehicles, the service brakes shall stop the vehicle within 40 ft (12.1 m) from 20 mph (32 km/h) and within 160 ft (48.8 m) from 40 mph (64 km/h).

2-9.2.4 Stopping distances shall be accomplished on a dry, hard, approximately level roadway free from loose material and with a roadway width equal to the vehicle width plus 4 ft (1.2 m) without any part of the vehicle leaving the roadway.

2-9.2.5 The service brakes shall provide 1 power-assisted stop with the vehicle engine inoperative, for the stopping distances specified above for each vehicle class.

2-9.3 An emergency brake system shall be provided that is applied and released by the driver from the cab and is capable of modulation, by means of the service brake control. With a single failure in the service brake system of a part designed to contain compressed air or brake fluid, other than failure of a common valve, manifold, brake fluid housing, or brake chamber housing, the vehicle shall stop in no more than 288 ft (88 m) from 40 mph (64 km/h) without any part of the vehicle leaving a dry, hard, approximately level roadway with a width equal to the vehicle width plus 4 ft (1.2 m).

2-9.4 The parking brake shall be capable of holding the fully loaded vehicle on a 20 percent grade without air or hydraulic assistance.

2-9.5 Brakes — Air System.

2-9.5.1 When the vehicle is supplied with air brakes, the air compressor shall meet the following criteria:

(a) the compressor shall be engine driven;

(b) the compressor shall have capacity sufficient to increase air pressure in the supply and service reservoirs

from 85 to 100 psi when the engine is operating at the vehicle manufacturer's maximum recommended revolutions per minute (rpm) in a maximum of 25 seconds;

(c) the compressor shall have the capacity for quick buildup of tank pressure from 5 psi to the pressure required to release the spring brakes, and this buildup in pressure shall be accomplished within 12 seconds; and

(d) the compressor shall incorporate an automatic air drying system immediately downstream from the compressor to prevent condensation buildup in all pneumatic lines.

2-9.5.2 Service reservoirs shall be provided. The calculated reservoir capacity shall include reservoirs, supply lines, and air dryer volumes. The total of the service reservoir volume shall be at least 12 times the total combined brake chamber volume at full stroke. If the reservoir volume is greater than the minimum required, proportionately longer buildup time shall be allowed using the following formula:

$$\frac{\text{Actual reservoir capacity} \times 25}{\text{required reservoir capacity}}$$

2-9.5.3 Reservoirs shall be equipped with drain and safety valves.

2-9.5.4 Provision shall be made for charging of air tanks by a pull away electrical connection used to power a vehicle-mounted auxiliary compressor.

2-9.5.4.1 When specified by the purchaser, a pull away air connection for charging of air tanks from an external air source shall be provided.

2-9.5.5 Visual and audible low air pressure warning devices shall be provided. The low pressure warning device shall be visual and audible from the inside of the vehicle and audible outside of the vehicle.

2-10 Steering.

2-10.1 The chassis shall be equipped with power-assisted steering with direct mechanical linkage from the steering wheel to the steered axle(s) to permit the possibility of manual control in the event of power assist failure.

2-10.2 The power steering system shall have sufficient capacity so that no more than 15 lb pull is required on the steering wheel rim in order to turn the steering linkage from stop to stop with the fully loaded vehicle stationary on a dry, level, paved surface with the engine at idle.

2-10.3 The wall-to-wall turning diameter of the fully loaded vehicle shall be less than 3 times the vehicle length.

2-11 Cab.

2-11.1 The cab shall be fully enclosed (floor, roof, and 4 sides) and mounted on the forward part of the vehicle. Crew seating positions shall be restricted to the cab. The maximum number of crew seat positions provided in the cab shall be designated by the manufacturer and so labeled in the cab. As a minimum, one designated seat position shall be provided for the driver ane one additional crew member. Seat belts, approved by the AHJ, shall be provided for each of the designated seating positions. Space shall be provided for all instrument controls and equipment specified without hindering the crew. Wide opening doors shall be provided on each side of the cab with the necessary steps and handrails to permit rapid and safe entrance and exit from the cab. Cab design shall take into consideration the provision of ample space for the crew to enter and exit the cab and carry out normal operations while wearing full protective equipment.

2-11.2 The cab shall meet the visibility requirements of 2-2.2.3. Interior cab reflections from exterior and interior lighting shall be minimized. The windshield shall be shatterproof safety glass, and all other windows shall be constructed of approved safety glass. The cab shall be provided with wide gutters to prevent foam and water dripping on the windshield and side windows. When equipped with a roof turret having manual controls above the cab roof, the cab shall be designed with a quick-access passage to the roof turret(s).

2-11.3 The cab shall be weatherproof and shall be fully insulated thermally and acoustically with a fire resistant material. The cab interior noise level at the driver's ear position shall not exceed 90 dBA while traveling at 50 MPH on a level hard surface. This noise level shall be achieved with the agent, communication, audible warning, and emergency warning systems inactive. The cab may be of the unitized rigid body and frame structure type, or it may be a separate unit flexibly mounted on the main vehicle frame. The cab shall be constructed from materials of adequate strength to ensure a high degree of safety for the crew under all operating conditions including excess heat exposure and in the event of a vehicle rollover accident.

2-11.4 Instruments, Warning Lights, and Controls.

2-11.4.1 The minimum number of instruments, warning lights, and controls consistent with the safe and efficient operation of the vehicle, chassis, and fire fighting system shall be provided. All chassis instruments and warning lights shall be grouped together on a panel in front of the driver. All fire fighting system instruments, warning lights, and controls shall be grouped together by function so as to provide ready accessibility and high visibility for the driver as well as a crew member.

2-11.4.2 All instruments and controls shall be illuminated, with backlighting to be used where practical.

2-11.4.3 Groupings of both the chassis and fire fighting system instruments, warning lights, and controls shall be easily removable as a unit or be on a panel hinged for back access by the use of quick disconnect fittings for all electrical, air, and hydraulic circuits.

2-11.4.4 The following instruments, or warning lights, or both shall be provided as a minimum:

(a) Speedometer/odometer
(b) Engine(s) tachometer
(c) Fuel level
(d) Air pressure
(e) Engine(s) temperature
(f) Engine(s) oil pressure
(g) Voltmeter(s)
(h) Transmission(s) oil temperature
(i) Pump(s) pressure
(j) Water tank level
(k) Foam tank level
(l) Low air pressure warning
(m) Headlight beam indicator.

2-11.4.5 The cab shall have all the necessary controls within easy reach of the driver for the full operation of the vehicle and the pumping system. The following cab controls shall be provided:

(a) Accelerator pedal
(b) Brake pedal
(c) Parking brake control
(d) Steering wheel, with directional signal control and horn
(e) Transmission range selector
(f) Pump control or selector
(g) Foam control
(h) Siren switch(es)
(i) Groundsweep valve control
(j) Undertruck valve control
(k) Remote turret controls when remote turret is provided
(l) Light switches
(m) Windshield wiper and washer controls
(n) Heater/defroster controls
(o) Master electrical switch
(p) Engine start/stop control.

2-11.5 Equipment.

2-11.5.1 The following minimum equipment shall be provided in or on the cab, as may be applicable:

(a) Heater/defroster

(b) Driver's suspension seat with vertical, fore, and aft adjustment, with seat belt

Exception: The use of a nonsuspension driver's seat shall be permitted when recommended by the manufacturer.

(c) Crew seats with individual retractable seat belts

(d) Windshield washers appropriate for removing foam

(e) Windshield wipers appropriate for removing foam

(f) Siren

(g) Horn

(h) Sun visors, interior transparent

(i) Outside rear view mirrors, as specified in 2-2.2.4

(j) Interior lighting.

(k) Provisions for mounting SCBA, of the type specified by the purchaser, at each crew seat position.

2-12 Body.

2-12.1 The body shall be constructed of materials that provide the lightest weight consistent with the strength necessary for off-pavement operation over rough terrain and when exposed to excess heat. 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 or wheel wells. Body panels shall be removable where necessary to provide access to the interior of the vehicle.

2-12.2 Access doors shall be provided for those areas of the interior of the vehicle that must be frequently inspected. In particular, access doors of sufficient size and number shall be provided for access to:

(a) Engine
(b) Pump
(c) Foam Proportioning System
(d) Battery Storage
(e) Fluid Reservoirs.

Other areas requiring access for inspection or maintenance shall be either open or have removable panels.

2-12.3 Suitable, lighted compartments shall be provided for convenient storage of equipment and tools to be carried on the vehicle. Compartments shall be weathertight and self-draining.

2-12.4 A working deck shall be provided and shall be adequately reinforced to permit the crew to perform their duties in the roof turret area, cab hatch area, water tank top fill area, foam-liquid top fill area, and in other areas where access to auxiliary or installed equipment is necessary.

2-12.5 Handrails or bulwarks shall be provided where necessary for the safety and convenience of the crew. Rails and stanchions shall be strongly braced and constructed of a material that is durable, resists corrosion, and provides a suitable gripping surface.

2-12.6 Steps or ladders shall be provided for access to the top fill area. The lowermost step(s) may extend below the angle of approach or departure or ground clearance limits if it (they) is (are) designed to swing clear. All other steps shall be rigidly constructed. All steps shall have a nonskid surface. Lowermost step(s) shall be no more than 22 in. (558 mm) above level ground when the vehicle is fully loaded. Adequate lighting shall be provided to illuminate steps and walkways.

2-12.7 A heavy-duty front bumper shall be mounted on the vehicle and secured to the frame structure.

2-12.8 Paint finish shall be selected for maximum visibility and shall be resistant to damage from fire fighting agents.

2-13 Agent Pump(s) and Pump Drive.

2-13.1 Agent Pump(s).

2-13.1.1 The water pump(s) shall be constructed of corrosion resistant metals and shall be single or multiple stage centrifugal type, designed for dependable emergency service. Pumps shall be carefully designed and built in accordance with good modern practice. Pumps shall be gravity primed from the vehicle tank. The pump and piping system shall be designed to eliminate the entrapment of air.

2-13.1.2 On those vehicles using a pump discharge side proportioning system, the foam-liquid pump or pumps shall be made of bronze or other materials resistant to corrosion by foam-liquid concentrate.

2-13.1.3 When discharging foam solution, the pumping system shall be capable of discharging at a rate equal to or exceeding total requirements of primary turrets, primary hand lines, ground sweep, and undertruck nozzles discharging simultaneously at designed pressures.

2-13.2 Pump Drive.

2-13.2.1 The pump(s) drive shall permit operation of the pump(s) and simultaneous operation of the vehicle. The pump(s) shall not be affected by changes in transmission ratios or the actuation of clutches in the vehicle drive. The design of the drive system and controls shall prevent damage to the drive or minimize lurching of the vehicle when the vehicle drive is engaged while pumping operations are in process. The pump(s) drive system shall be capable of absorbing the maximum torque delivered by the engine to the pump(s) and withstanding the engagement of the pump(s) at all engine and vehicle speeds and under all operating conditions. The operation of the pump(s) shall not, under any conditions, cause the engine to stall or cause more than a slight and momentary reduction in engine speed and consequent drop in pump pressure.

2-13.2.2 While pumping at rated capacity, the drive shall permit controlled vehicle operation at speeds from 1 mph to 5 mph. The pump(s) drive shall have sufficient power capacity to provide the pump(s) discharge requirements of 2-13.1.3 while the vehicle is being propelled under all operating conditions where a fire fighting capability is required.

2-13.2.3 If an independent engine is used to drive the pump, it shall have the same fuel and electrical system as the chassis engine and shall be equipped with an air cleaner, a replaceable element oil filter, a full pressure lubricating system, and an overspeed governing device to prevent engine damage. The engine shall also be provided with a cooling system that meets the requirements of 2-3.2.1 or 2-3.2.2.

2-13.3 Suction Connections.

2-13.3.1 The suction system shall be designed for efficient flow at the pumping rates required by 2-13.1.3. The pump suction line(s) 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 corrosion-resistant materials.

2-13.3.2 When 2 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.

2-13.4 Discharge Connections.

2-13.4.1 All discharge outlets shall have National (American) Standard fire hose coupling thread. Adapter couplings, securely attached, shall be provided on each outlet if local couplings are not National (American) Standard as specified in NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections*. No outlet or outlet with adaptors shall add width to the vehicle.

2-13.5 Piping, Couplings, and Valves.

2-13.5.1 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 or galvanic action.

2-13.5.2 Piping shall be securely mounted and provided with flexible couplings to minimize stress. Union or rubber gasketed fittings shall be provided where required to facilitate removal of piping.

2-13.5.3 All valves shall be quarter-turn type and selected for ease of operating and freedom from leakage.

2-13.5.4 All water system piping shall be tested on the suction side of the pump to detect possible leakage. All water and foam solution discharge piping, together with the agent pump(s), shall be tested at 50 percent above system operating pressure.

2-13.6 Overheat Protection.

2-13.6.1 A system line shall be provided from the water pump discharge and, if applicable, from the foam pump discharge to prevent overheating of the pumps while engaged and operating at zero discharge. The line shall be automatic.

2-13.7 Pressure Relief Valves.

2-13.7.1 A pressure relief valve shall be fitted both to protect and ensure optimum performance of the system.

2-13.8 Drains.

2-13.8.1 A drainage system, with collector tubing from the low points on pump(s) and piping shall be provided. The drain shall be provided with a quarter-turn valve.

2-14 Water Tank.

2-14.1 Capacity.

2-14.1.1 A water tank shall have a usable capacity as specified in 2-1.2.

2-14.1.2 The rated capacity of the tank shall be equal to the usable capacity that can be pumped from the tank while the vehicle is parked on level ground. The tank outlets shall be arranged to permit use of at least 75 percent of the rated capacity with the vehicle positioned on:

(a) 20 percent side slope

(b) 30 percent ascending grade

(c) 30 percent descending grade.

2-14.2 Construction.

2-14.2.1 The tank shall be constructed to resist all forms of deterioration that could be caused by the water and foam concentrate while affording the structural integrity required for off-road operation. The tank shall have longitudinal and transverse baffles. The construction and connections shall be made to prevent the possibility of galvanic corrosion of dissimilar metals.

2-14.2.2 The tank shall be equipped with easily removeable manhole covers over the tank discharge. The tank shall be designed to permit access within each baffled compartment of the tank for internal and external inspection and service. The tank shall have drain valves.

2-14.2.3 Provisions shall be made for necessary overflow and venting. Venting shall be sized to permit agent discharge at the maximum design flow rate without danger of tank collapse and shall be sized to permit rapid and complete filling without exceeding the internal pressure design limit of the tank. Additionally, overflows shall be designed to prevent loss of water from the tank during normal maneuvering and to direct the discharge of overflow water directly to the ground.

2-14.2.4 The water tank shall be mounted in a manner that limits the transfer of the torsional strains from the chassis frame to the tank during off-pavement driving. The tank shall be separate and distinct from the crew compartment, engine compartment, and chassis and easily removable as a unit.

2-14.2.5 The water tank shall be equipped with at least 1 top fill opening of not less than 5 in. (12.7 cm) internal diameter. The top fill shall be equipped with an easily removable strainer of 1/4 in. (6 mm) mesh construction. The top fill opening shall be equipped with a cap designed to prevent spillage.

2-14.3 Tank Fill Connection(s).

2-14.3.1 Tank fill connection(s) shall be provided in a position where they can be easily reached from the ground.

2-14.3.2 All connections shall have National (American) Standard fire hose coupling threads. Adapters, securely attached, shall be provided on each connection if local couplings are not National (American) Standard. Connections and adapter threads shall be as specified in NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections*. Connections and connections with adapters attached shall not protrude beyond the normal body metal work of the vehicle.

2-14.3.3 The connection(s) shall be provided with strainers of 1/4 in. (6 mm) mesh and shall have check valves or be so constructed that water will not be lost from the tank when connection or disconnection is made.

2-14.3.4 The tank fill connection(s) shall be sized to permit filling of the water tank in 2 minutes at a pressure of 80 psi (5.5 bar) at the tank intake connection.

2-15 Foam System.

2-15.1 All components of the foam system, including the foam-liquid tank, piping, fill troughs, screens, etc., shall be made of materials resistant to corrosion by the foam-liquid concentrate, foam-water solution, and water.

2-15.2 Foam-Liquid Concentrate Tank(s).

2-15.2.1 The purchaser shall specify the percent concentrate foam system to be provided. The foam-liquid concentrate tank(s) shall have a working capacity sufficient for 2 tanks of water.

2-15.2.2 Foam-liquid concentrate tanks may be of either rigid or flexible type. The tank(s) shall be designed for compatability with the foam concentrate being used and resist all forms of deterioration which could be caused by the foam concentrate or water.

2-15.2.3 Tanks shall be designed to permit access within each baffled compartment of the tank for internal and external inspection and service. A large capacity drain connection shall be installed flush with the bottom of the sump.

2-15.2.4 The tank outlets shall be located above the bottom of the sump and shall provide continuous foam-liquid concentrate to the foam proportioning system, with that system operating as specified in 2-15.5, and with the vehicle discharging 2 tank loads of usable water as specified in 2-14.1.

2-15.2.5 If separate from the water tank, the foam-liquid tank shall be mounted in a manner that limits the transfer of the torsional strains from the chassis frame to the tank during off-pavement driving. The tank shall be separate and distinct from the crew compartment, engine compartment, and chassis and shall be easily removable as a unit.

2-15.2.5.1 A flexible tank shall be structurally supported to resist tearing. The structural support shall not be dependent on the fluid level in either the water or foam tanks.

2-15.2.6 A top fill trough shall be provided, equipped with a stainless steel no. 10 mesh screen and container openers to permit emptying 5-gal (18.9-L) foam-liquid concentrate containers into the storage tank(s) at a rapid rate regardless of water tank level. The trough shall be connected to the foam-liquid storage tank(s) with a fill line designed to introduce foam-liquid concentrate near the bottom of the tank(s) to minimize foaming within the storage tank.

2-15.2.7 Tank fill connection(s) shall be provided in a position where they can be easily reached from the ground to permit the pumping of foam-liquid concentrate into the storage tank(s). The connection(s) shall be provided with strainers of 1/4-in. (6-mm) mesh, and shall have check valves or be so constructed that foam will not be lost from the tank when connection or disconnection is made.

2-15.2.7.1 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 shall be capable of delivering foam-liquid at a rate at least equal to or greater than the maximum discharge rate of the foam system.

2-15.2.8 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. The vent outlets shall be directed to the ground to prevent spillage of foam-liquid concentrate on vehicle components.

2-15.3 Foam-Liquid Concentrate Pump.

2-15.3.1 The foam-liquid concentrate system shall be so arranged that the entire piping system including the foam-liquid concentrate pump or pumps can be readily flushed with clear water.

2-15.3.2 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.

2-15.4 Foam-Liquid Concentrate Piping.

2-15.4.1* The foam-liquid concentrate piping shall be of material resistant to corrosion by foam-liquid concentrate. Care shall be taken 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.

2-15.4.2 The foam-liquid concentrate piping shall be adequately sized to permit the maximum required flow rate and shall be arranged to prevent water from entering the foam tank.

2-15.5 Foam-Liquid Proportioning Systems.

2-15.5.1 The foam concentrate proportioning system shall provide a means of controlling the ratio of foam concentrate to the quantity of water in the foam solution being discharged from all orifices normally used for aircraft fire fighting operations.

2-15.5.2 The proportioning system shall be sufficiently accurate to provide for the discharge of finished foam within the range of 2.8 percent to 3.5 percent foam concentrate in the discharged foam/water solution for a 3 percent concentrate or 5.5 percent to 7.0 percent for a 6 percent concentrate.

2-15.6 Turret Nozzles.

2-15.6.1 Major aircraft rescue and fire fighting vehicles shall have 1 or 2 primary turret nozzles. The primary turret nozzle(s) shall meet the requirements of 2-15.6.2 and 2-15.6.3.

2-15.6.2 The total foam solution discharge rate from the primary turret, or pair of primary turrets, shall be as specified in Table 2-15.6.2 and shall be such that the rated capacity of the tank can be discharged in not more than 2 minutes and not less than 1 minute.

Table 2-15.6.2 Minimum Turret Discharge Rates

Vehicle Class	Minimum Rated Tank Capacity Gal	(L)	Turret Minimum Flow Rate gpm	(L/min)
1	1000	(4,000)	500	(2000)
2	1500	(6,000)	750	(3000)
3	2500	(9,000)	1250	(5000)
4	3000	(11,000)	1500	(6000)

For tanks with rated capacities greater than the minimum rated capacity given for each class, the minimum gpm (L/min) discharge rate of foam solution shall be determined by dividing the rated tank capacity by 2. For Class 3 and 4 vehicles, the maximum rated turret discharge capacity shall not exceed 2000 gpm (8000 L/min).

2-15.6.3 Turret(s) shall be capable of discharging foam as specified in Table 2-15.6.3 in still air in a continuously variable pattern with the turret(s) elevated to the maximum stream reach position.

Table 2-15.6.3

Vehicle Class	Straight Stream Minimum Range Far Point in Ft (m)	Dispersed Stream Minimum Width in Ft (m)	Dispersed Stream Minimum Range Far Point in Ft (m)
1	160 (49 m)	35 (10 m)	60 (18 m)
2	190 (58 m)	35 (10 m)	65 (20 m)
3	230 (70 m)	35 (10 m)	70 (21 m)
4	250 (76 m)	35 (10 m)	75 (23 m)

2-15.6.4 Turret nozzles with liquid flow rates of 750 gpm (3000 L/min) or more shall be of the dual discharge type and arranged to permit selection of either 50 percent or 100 percent of the turret capacity. The roof turret discharge rates shall have a tolerance of −0% or +10%.

2-15.6.5 Turrets may be manually operated or power controlled. Where turret remote control is provided in the cab, operating forces shall be less than 30 lb (13.5 kgf), and cab indication of turret elevation and azimuth shall be provided. Where turret control is at the platform, operating forces shall be less than 50 lb (22.5 kgf). All power-assisted controls shall have identical operating characteristics. Manual controls and overrides shall be provided at the turret platform.

2-15.6.6 Turrets shall be capable of being elevated at least 45° above the horizontal and depressed to discharge agent within 30 ft (9 m) in front of the vehicle at full output using dispersed stream. Where a single turret is used on a vehicle, it shall be capable of being rotated not less than 105° to either side, total traverse not less than 210°. Where 2 turrets are used on a vehicle, suitable stops shall be provided so that neither turret can interfere with the other turret.

2-15.7 Primary Hand Lines.

2-15.7.1 Major aircraft rescue and fire fighting vehicles shall have a minimum of 2 primary hand lines that meet the requirements of either 2-15.7.3 or 2-15.7.4. The 2 primary hand lines shall not be located on the same side of the vehicle.

2-15.7.1.1 Primary hand lines shall be those hand lines for discharging foam streams that are specified by the purchaser as intended for use as primary crash/fire/rescue attack equipment. All other hand lines that may be installed on the vehicle for discharging either water or foam or both shall be considered as additional hand lines and not primary hand lines.

2-15.7.2 The purchaser shall specify either 2 reeled hand lines specified in 2-15.7.3 or 2 woven jacket hand lines specified in 2-15.7.4 or 1 of each.

2-15.7.3 Reeled Hand Lines.

2-15.7.3.1 Hand lines for reels shall have a minimum internal diameter of 1 inch, shall have a minimum burst pressure rating at least 3 times greater than the nominal working pressure of the system, and shall be able to discharge the gpm (L/min) required in 2-15.7.3.3 without unreeling the hose.

2-15.7.3.2 At least 100 ft (30 m) of hose shall be provided for each reel.

2-15.7.3.3 Each hand line shall be equipped with a shutoff type nozzle designed to discharge both foam and water at a nominal discharge rate of 60 gpm (240 L/min) ±5%. Each nozzle shall have minimum foam discharge patterns from a dispersed stream of 15 ft (4.5 m) width and 20 ft (6 m) range, to a straight foam stream with a 50 ft (15 m) range.

2-15.7.3.4 Each reel shall have capacity for at least 100 ft (30 m) of 1-in. (2.5-cm) hose or more if specified by the purchaser.

2-15.7.3.5 Each reel shall be designed and positioned to permit hose line removal by a single person from any position in a 120° horizontal sector. Each reel shall be equipped with a friction brake to prevent hose from unreeling when not desired. Power rewind with manual override shall be provided. The nozzle holder, friction brake, rewind controls, and manual valve control shall be accessible from the ground.

2-15.7.3.6 Flow to each reel shall be controlled by a manually operated quarter-turn ball-type valve.

2-15.7.4 Woven Jacket Hand Lines.

2-15.7.4.1 Woven jacket hose lines shall have a minimum diameter of 1½ in. (38 mm) and shall meet the requirements of NFPA 1961, *Standard for Fire Hose.*

2-15.7.4.2 At least 150 ft (45 m) of hose shall be provided each hand line.

2-15.7.4.3 Each hand line shall be equipped with a shutoff-type nozzle designed to discharge both foam and water at a nominal discharge rate of 95 gpm (380 L/min) ±5%. Each nozzle shall have minimum foam discharge patterns from a dispersed stream of 15 ft (4.5 m) width and 20 ft (6 m) range, to a straight foam stream with a 65 ft (20 m) range.

2-15.7.4.4 Each hand line shall be stored in a hose compartment and shall be preconnected. Each hose compartment shall have a capacity for a minimum of 150 ft (45 m) of 1½ in. (38 mm) multiple jacket hose or more if specified by the purchaser.

2-15.7.4.5 Hose compartments shall be fabricated from noncorrosive material and shall be designed to drain effectively. The compartment shall be smooth and free from all projections that might damage hose. No other equipment shall be mounted or located where it will obstruct the removal of the hose. The hose compartment shall not be more than 5½ ft (1.6 m) above the ground.

2-15.7.4.6 Flow to each hand line shall be controlled by a manually operated quarter-turn ball-type valve, located adjacent to the hand line.

2-15.8 Ground Sweep and Undertruck Nozzles.

2-15.8.1 Vehicles shall have a ground sweep nozzle or nozzles capable of discharging at least a nominal 100 gpm (400 L/min) −0%, +10% at the recommended operating pressure in a flat pattern 12 ft (3.6 m) wide with a 30 ft (9 m) range. The ground sweep valve shall be controlled from the cab interior within easy reach of the driver and a crew person. When specified by the purchaser, a bumper turret may be provided in place of ground sweep nozzles.

2-15.8.2 Two or more undertruck nozzles shall be mounted under the truck and controlled from the cab. A sufficient number shall be provided to protect the bottom of the vehicle and the inner sides of the wheels and tires with foam solution discharged in a spray pattern.

2-15.9 Foam Quality.

2-15.9.1 Turrets, hand lines, and ground sweeps shall discharge foam having the quality specified in Table 2-15.9.1.

Measurement of expansion ratio and 25 percent drainage times shall be in accordance with the procedures outlined in NFPA 412, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles.*

2-16 Lighting and Electrical Equipment.

2-16.1 Lighting equipment shall be installed in conformity with local road regulations when practicable and shall include the following:

(a) Headlights with upper and lower driving beams. A control switch that is readily accessible to the driver, shall be provided for beam selection.

(b) Dual taillights and stoplights.

(c) Turn signals, front and rear, with a steering column mounted control and a visual and audible indicator. A four-way flasher switch shall be provided.

(d) Spotlight, 6 in. (152 mm) minimum on both left and right sides of the windshield, hand adjustable type, with controls for beam adjustment inside the truck cab.

Table 2-15.9.1

	Protein and Fluoroprotein Air-aspirating Nozzles		Foam-Liquid Type AFFF Air-aspirating Nozzles		AFFF Nonair-aspirating Nozzles	
	Expansion Ratio	Minimum 25 percent Drainage in Minutes	Minimum Expansion Ratio	Minimum 25 percent Drainage in Minutes	Minimum Expansion Ratio	Minimum 25 percent Drainage in Minutes
Turrets	8 to 12	5	5	4	3	1
Hand Lines	8 to 12	5	5	4	3	1
Ground Sweeps	8 to 12	5	5	4	3	1

(e) Adequate reflectors, and marker and clearance light, shall be furnished to describe the overall length and width of the vehicle.

(f) Engine compartment lights, nonglare type, arranged to illuminate both sides of the engine with individual switches located in the engine compartment.

(g) Lighting shall be provided for all top deck working areas.

(h) At least 1 back-up light and an audible alarm installed in the rear of the body.

(i) 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.

2-16.2* A warning siren shall be provided having a sound output of not less than 95 decibels at 100 ft (30 m) directly ahead of the siren and not less than 90 decibels at 100 ft (30 m) measured at 45° 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.

2-16.3 A horn shall be provided and shall be mounted at the front part of the vehicle with the control positioned such that it is readily accessible to the driver.

2-16.4 Radios.

2-16.4.1 Provision shall be made for mounting radios. Operation of the radios shall be from the cab. Radios shall be mounted permitting quick servicing or replacement.

2-16.4.2 Purchaser shall specify radios that will ensure that all required radios and frequencies are provided for.

2-17 Tools.

2-17.1* Provision shall be made for mounting tools and equipment on the truck. Special tools as required for servicing the vehicle, fire suppression system, and any of the auxiliary equipment shall be furnished by the vehicle manufacturer.

Chapter 3 Rapid Intervention Vehicles (RIV)

3-1 General.

3-1.1 The RIV shall have a minimum rated water capacity of 600 gal (2400 L). The primary extinguishing agent shall be AFFF with either a premixed or proportioning system. In addition to the primary agent, there shall be an auxiliary extinguishing agent of a nominal 500 lb (225 kg) or more of either dry chemical or Halon 1211.

3-2 Weights and Dimensions.

3-2.1 Weight.

3-2.1.1 The actual gross vehicle weight of the fully staffed, loaded, and equipped vehicle ready for service shall not exceed the manufacturer's gross vehicle weight rating.

3-2.1.2 The weight shall be distributed as equally as practical over the axles and tires of the fully loaded vehicle. The difference in weight between tires on any axle shall not exceed 5 percent of the average tire weight for that axle, and the difference in weight between axles shall not exceed 10 percent of the weight of the heaviest axle. The front axle shall not be the heaviest axle. Under no circumstances shall axle and tire manufacturer's ratings be exceeded.

3-2.1.3 The center of gravity of the vehicle shall be kept as low as possible under all conditions of loading. The vehicle shall be able to stand on a sideways slope of 35° (70 percent). The vehicle shall also be driven on a steering pad around a circle of 100 ft (30 m) radius. The steering wheel rotation shall increase with increasing speed. A speed of at least 25 mph (40 km/h) shall be obtained.

3-2.2 Dimensions.

3-2.2.1 Underchassis clearance of the vehicle shall permit mobility in soft soils and rough terrain with the vehicle's tires inflated to highway inflation pressures. The following shall be minimum dimensions:

Angle of Approach — 30°

Angle of Departure — 30°

Interaxle Clearance Angle — 12°

Underaxle Clearance — 13 in. (330 mm) under axle differential housing bowl.

Under-Body Clearance — 18 in. (458 mm).

3-2.2.2* Overall height, length, and width dimensions shall be held to a minimum consistent with the best operational performance of the vehicle and the design concepts needed to achieve this performance and to provide optimum maneuverability and facilitate movement on public highways.

3-2.2.3 The vehicle shall be constructed such that a seated driver, having an eye reference point of 31¾ in. (805 mm) above the seat cushion and 12 in. (30.5 cm) forward from the seat back, shall be able to see the ground 20 ft (6 m) ahead of the vehicle and have vision of at least 5° above the horizontal plane. The vision in the horizontal plane shall be at least 90% on each side from the straight ahead position.

3-2.2.4 Adjustable rear view mirrors with a glass area of not less than 60 sq in. (385 cm^2) shall be provided on each side of the vehicle. Each shall be provided with a minimum of a 7 sq in. (45.2 cm^2) area wide angle convex mirror.

3-3 Engine.

3-3.1 Performance Requirements.

3-3.1.1 The vehicle engine(s) shall have horsepower, torque, and speed characteristics to meet and maintain all vehicular performance characteristics specified in this standard. The engine manufacturer shall certify that the installed engine is approved for this application.

3-3.1.2* The fully loaded vehicle shall consistently be able to accelerate from 0-50 mph (0-80 km/h) in 20 seconds on dry level concrete pavement at the operational airport. Maximum speed shall not be less than 65 mph (104 km/h).

The above acceleration times shall be achieved with the engine and transmission at their normal operating temperature at any ambient temperature varying from 0°F (-18°C) to 110°F (43°C) and at elevations up to 2,000 feet (609 m) above sea level unless a higher elevation is specified.

Airports above 2,000 ft (609 m) shall state the elevation at which the vehicle will operate in order to ensure the required performance.

3-3.1.3 The vehicle shall also be capable of ascending, stopping, starting, and continuing ascent on a 40 percent grade on dry pavement at a speed up to at least 1 mph (1.6 km/h) with extinguishing agents being discharged at maximum rated capacity from the turret(s).

3-3.2 Engine Cooling.

3-3.2.1 Liquid Cooled Engines.

3-3.2.1.1 The cooling system shall be designed so that the stabilized engine coolant temperature remains within engine manufacturer's prescribed limits under all operational conditions and at all ambient temperatures encountered at the operational airport. The cooling system shall be provided with an automatic thermostat for rapid engine warming.

3-3.2.1.2 Radiator shutters, when furnished for cold climates, shall be of the automatic type and shall be designed to open automatically upon failure.

3-3.2.2 Air-Cooled Engines.

3-3.2.2.1 Air-cooled engines shall be designed so that the stabilized cylinder head and oil temperatures remain within the engine manufacturer's prescribed limits under all operational conditions and at all ambient temperatures encountered at the operational airport.

3-3.3 Fuel Systems.

3-3.3.1 A complete fuel system requiring engine manufacturer's installation approval shall include a fuel pump, fuel filtration, and flexible fuel lines where necessary that shall be protected from damage, exhaust heat, and exposure to ground fires.

3-3.3.2 Accessible filtration shall be provided for each fuel supply line and a drain shall be provided at the bottom of the fuel tank.

3-3.3.3 Fuel tanks shall not be installed in a manner that permits gravity feed.

3-3.3.4 Fuel tank capacity shall be at least 30 gal (120 L).

3-3.4 Exhaust System.

3-3.4.1 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 system shall be of high grade, rust resistant materials.

3-3.4.2 The exhaust system shall be protected from damage that could result from traversing rough terrain. Tailpipe shall be designed to discharge upward or to the rear and shall not be directed toward the ground.

3-4 Vehicle Electrical System.

3-4.1 The vehicle shall be provided with one of the following electrical systems:

(a) 12 volt electrical and starting
(b) 24 volt electrical and starting
(c) 12 volt electrical/24 volt starting.

3-4.2 The electrical system shall have negative ground including transistorized alternator and a fully transistorized voltage regulator. The alternator shall be rated at 100 percent of anticipated load at 50 percent engine governed speed and shall, if belt driven, be driven by dual belts.

3-4.2.1 For 12 volt electrical and starting systems and for 12 volt electrical/24 volt starting systems, the curb idle minimum charging rate of the alternator shall be 50 amp.

3-4.2.2 For 24 volt electrical and starting systems, the curb idle minimum charging rate of the alternator shall be 30 amp.

3-4.3 Batteries shall be securely mounted and adequately protected against physical injury and vibration, water spray, and engine and exhaust heat. When an enclosed battery compartment is provided, it shall be adequately ventilated, and the batteries shall be readily accessible for examination, test, and maintenance.

3-4.3.1 For 12 volt systems, there shall be two 12 volt batteries connected in parallel, 200 amp hr capacity each at 20 hr rate.

3-4.3.2 For 24 volt systems, there shall be two 24 volt batteries, connected in parallel, 100 amp hr capacity each at 20 hr rate; four 12 volt batteries connected in series parallel, 100 amp hr capacity each at 20 hr rate; or two 12 volt batteries connected in series at a 200 amp hr capacity each at 20 hr rate.

3-4.4 Battery capacity and wiring circuits provided, including the starter switch and circuit and the starter to battery connections, shall meet or exceed the manufacturer's recommendations. A master battery disconnect switch shall be provided.

3-4.4.1 For 12 volt electrical/24 volt starting systems, there shall be two 12 volt batteries connected in series parallel through a solid state series parallel circuit to accomplish 24 volt starting. The batteries shall have 200 amp hr capacity each at 20 hr rate.

3-4.5 A built-in battery charger shall be provided on the vehicle to maintain full charge on all batteries. Grounded ac receptacle shall be provided to permit a pull away connection from local electric power supply to battery charger.

3-4.6 An engine coolant preheating device shall be provided as an aid to rapid starting and high initial engine performance.

3-4.7 The electrical system shall be insulated, waterproofed, and protected against exposure from ground fires. All wiring shall be coded in some manner to correspond with the wiring diagram provided with the vehicle. Circuit protection shall be provided to protect the vehicle in the event of electrical overload.

3-4.8 Radio suppression of the electrical system shall be in accordance with SAE J551 *Standard on Performance Levels and Methods of Measurement of Electromagnetic Radiation from Vehicles and Devices (20-1000 MHz)* or an equivalent radio suppression standard.

3-5 Vehicle Drive.

3-5.1 Transmission of power from the engine to the wheels of the vehicle shall be through a torque converter and automatic gearbox. The entire drive train shall be designed and rated by the component manufacturer as having sufficient capacity to slip the wheels of the static loaded vehicle on a surface having a coefficient of friction of 0.8. A range of gears providing the specified top speed and a grade ability of 50 percent shall be provided with sufficient intermediate gears to achieve the specified acceleration. The transmission shall be properly matched to the engine and be approved for the application by the transmission manufacturer.

3-5.1.1 A transmission cooling system shall be provided and designed so that the stabilized transmission oil temperature remains within the transmission manufacturer's prescribed limits under all operational conditions and at all ambient temperatures encountered at the operational airport.

3-5.2 The provision of positive drive to each wheel by means of a fully locked driveline shall be required in order to maximize traction on low friction surfaces. Positive drive may be achieved either by the use of automatic locking and torque proportioning differentials or may be manually selectable by the seated driver, while the vehicle is in motion, by use of a single control.

3-5.3 All-wheel drive on these vehicles shall incorporate a drive to the front and rear axles that is engaged at all times during the intended airport service. An interaxle differential shall be installed with automatic or driver selected means of differential locking.

3-5.4 All traction increasing devices shall be operated by a single control for driving simplicity.

3-5.5 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 percent of the tire sectional width at rated load.

3-6 Suspension.

3-6.1 The suspension system shall be designed to permit the loaded vehicle to:

(a) travel at the specified speeds over improved surface;

(b) travel at moderate speeds over unimproved surface;

(c) provide diagonally opposite wheel motion 14 in. above ground obstacles without raising the remaining wheels from the ground;

(d) prevent damage to the vehicle caused by wheel movement; and

(e) provide a good environment for the crew when traveling over all surfaces.

3-7 Rims, Tires, and Wheels.

3-7.1 Vehicles shall be required to have off-highway mobility while meeting the specified paved surface performance.

3-7.2 Tires shall be selected to maximize the acceleration, speed, braking, and maneuvering capabilities of the vehicle on paved surfaces without sacrificing performance on all reasonable terrains found within the airport boundary.

3-7.3* The purchaser shall provide a tire description that reflects the off-road performance requirements necessitated by the soil conditions encountered at the operational airport. Soil conditions that may vary from an extremely fine grain soil or clay to an extremely coarse grain soil, sand, or gravel in a dry, saturated, or frozen condition shall be considered.

To optimize flotation under soft ground conditions, tires of larger diameter or width, or both, than are needed for weight carrying alone shall be specified. Similarly, the lowest tire pressure compatible with the high speed performance requirements shall also be specified.

3-7.4 Vehicle and tire manufacturers shall be consulted for tread design most suitable for specific soil composition at individual airports.

3-7.5 All wheels on the vehicle shall be of the single wheel type with all rims, tires, and wheels of identical size and same tire tread design.

3-7.6 Rims, tires, wheels, and inflation pressures shall be approved by the respective manufacturers as having sufficient capacity to meet the specified performance and shall be certified for not less than 5 mi (8 km) of continuous operation at 65 mph (100 km/h) at normal operational pressure.

3-8 Towing Connections.

3-8.1 Four large tow eyes or tow hooks, capable of towing the vehicle on level ground without damage, shall be mounted, 2 at the front and 2 at the rear of the truck and attached directly to the frame structure. Recovery of the vehicle from adverse conditions shall be made by attaching to the axles.

3-9 Brakes.

3-9.1* The braking system shall feature service, emergency, and parking brake systems. Service brakes shall be power actuation air, hydraulic, or air over hydraulic. Expanding shoe and drum brakes or caliper disc brakes shall be 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 bowl.

3-9.2 Service brakes shall be of the all-wheel type with split circuits so that failure of one circuit shall not cause total service brake failure.

3-9.2.1 The service brakes shall be capable of holding the fully loaded vehicle on a 50 percent grade.

3-9.2.2 The service brakes shall stop the vehicle within 35 ft (10.7 m) from 20 mph (32 km/h) and within 131 ft from 40 mph (64 km/h).

3-9.2.3 The above stopping distances shall be accomplished on a dry, hard, approximately level roadway free from loose material, and with a roadway width equal to the vehicle width plus 4 ft (1.2 m) without any part of the vehicle leaving the roadway.

3-9.2.4 The service brakes shall provide one power-assisted stop with the vehicle engine inoperative, for the stopping distances specified above for each vehicle class.

3-9.3 An emergency brake system shall be provided that is applied and released by the driver from the cab and is capable of modulation, by means of the service brake control. With a single failure in the service brake system of a part designed to contain compressed air or brake fluid, other than failure of a common valve, manifold, brake fluid housing, or brake chamber housing, the vehicle shall stop in no more than 288 ft (88 m) from 40 mph (64 km/h) without any part of the vehicle leaving a dry, hard, approximately level roadway with a width equal to the vehicle width plus 4 ft (1.2 m).

3-9.4 The parking brake shall be capable of holding the fully loaded vehicle on a 20 percent grade without air or hydraulic assistance.

3-9.5 Brakes — Air System.

3-9.5.1 When the vehicle is supplied with air brakes, the air compressor shall meet the following criteria:

(a) the compressor shall be engine driven;

(b) the compressor shall have capacity sufficient to increase air pressure in the supply and service reservoirs from 85 to 100 psi when the engine is operating at the vehicle manufacturer's maximum recommended revolutions per minute (rpm) in a maximum of 25 seconds;

(c) the compressor shall have the capacity for quick buildup of tank pressure from 5 psi to the pressure required to release the spring brakes, and this buildup in pressure shall be accomplished within 12 seconds; and

(d) the compressor shall incorporate an automatic air drying system immediately downstream from the compressor to prevent condensation buildup in all pneumatic lines.

3-9.5.2 Service reservoirs shall be provided. The calculated reservoir capacity shall include reservoirs, supply lines, and air dryer volumes. The total of the service reservoir volume shall be at least 12 times the total combined brake chamber volume at full stroke. If the reservoir volume is greater than the minimum required, proportionately longer buildup time shall be allowed using the following formula:

$$\frac{\text{Actual reservoir capacity} \times 25}{\text{required reservoir capacity}}$$

3-9.5.3 Reservoirs shall be equipped with drain and safety valves.

3-9.5.4 Provision shall be made for charging of air tanks by a pull away electrical connection used to power a vehicle-mounted auxiliary compressor.

3-9.5.4.1 When specified by the purchaser, a pull away air connection for charging of air tanks from an external air source shall be provided.

3-9.5.5 Visual and audible low air pressure warning devices shall be provided. The low pressure warning device shall be visual and audible from the inside and audible outside of the vehicle.

3-10 Steering.

3-10.1 The chassis shall be equipped with power-assisted steering with direct mechanical linkage from the steering wheel to the steered axle(s) to permit the possibility of manual control in the event of power assist failure.

3-10.2 The power steering system shall have sufficient capacity so that no more than 15 lb pull is required on the steering wheel rim in order to turn the steering linkage from stop to stop with the fully loaded vehicle stationary on a dry, level, paved surface with the engine at idle.

3-10.3 The wall-to-wall turning diameter of the fully loaded vehicle shall be less than 3 times the vehicle length.

3-11 Cab.

3-11.1 The cab shall be fully enclosed (floor, roof, and 4 sides) and mounted on the forward part of the vehicle. Crew seating positions shall be restricted to the cab. The maximum number of crew seat positions provided in the cab shall be designated by the manufacturer and so labeled in the cab. As a minimum, 1 designated seat position shall be provided for the driver and 1 additional crew member. Seat belts, approved by the authority having jurisdiction, shall be provided for each of the designated seating positions. Space shall be provided for all instrument controls and equipment specified without hindering the crew. Wide opening doors shall be provided on each side of the cab with the necessary steps and handrails to permit rapid and safe entrance and exit from the cab. Cab design shall take into consideration the provision of ample space for the crew to enter and exit the cab and carry out normal operations while wearing full protective equipment.

3-11.2 The cab shall meet the visibility requirements of 3-2.2.3. Interior cab reflections from exterior and interior lighting shall be minimized. The windshield shall be shatterproof safety glass, and all other windows shall be constructed of approved safety glass. The cab shall be provided with wide gutters to prevent foam and water dripping on the windshield and side windows. When equipped with a roof turret having manual controls above the cab roof, the cab shall be designed with a quick-access passage to the roof turret(s).

3-11.3 The cab shall be weatherproof and shall be fully insulated thermally and acoustically with a fire-resistant material. The cab interior noise level at the driver's ear position shall not exceed 90 dBA while traveling at 50 mph (80.5 km/hr) on a level hard surface. This noise level will be achieved with the agent, communication, audible warning, and emergency warning systems inactive. The cab may be of the unitized rigid body and frame structure type, or it may be a separate unit flexibly mounted on the main vehicle frame. The cab shall be constructed from materials of adequate strength to ensure a high degree of safety for the crew under all operating conditions including excess heat exposure and in the event of a vehicle rollover accident.

3-11.4 Instruments, Warning Lights, and Controls.

3-11.4.1 The minimum number of instruments, warning lights, and controls consistent with the safe and efficient operation of the vehicle, chassis, and fire fighting system shall be provided. All chassis instruments and warning lights shall be grouped together on a panel in front of the driver. All fire fighting system instruments, warning lights, and controls shall be grouped together by function so as to provide ready accessibility as well as high visibility for the driver as well as a crew member.

3-11.4.2 All instruments and controls shall be illuminated, with backlighting to be used where practical.

3-11.4.3 Groupings of both the chassis and fire fighting system instruments, warning lights, and controls shall be easily removable as a unit or be on a panel hinged for back access by the use of quick disconnecting fittings for all electrical, air, and hydraulic circuits.

3-11.4.4 The following instruments, or warning lights, or both shall be provided as a minimum:

(a) Speedometer/odometer
(b) Engine(s) tachometer
(c) Fuel level
(d) Air pressure, when specified
(e) Engine(s) temperature
(f) Engine(s) oil pressure
(g) Voltmeter(s)
(h) Transmission(s) oil temperature
(i) Pump(s) pressure
(j) Water tank level
(k) Foam tank level, when specified
(l) Low air pressure warning
(m) Headlight beam indicator.

3-11.4.5 The cab shall have all the necessary controls within easy reach of the driver for the full operation of the vehicle and the pumping system. The following cab controls shall be provided:

(a) Accelerator pedal
(b) Brake pedal
(c) Parking brake control
(d) Steering wheel, with directional signal control and horn
(e) Transmission range selector
(f) Pump control or liquid agent pressurization control
(g) Foam control, when foam proportioning system is provided
(h) Siren switch(es)
(i) Auxiliary agent pressurization control
(j) Undertruck valve control
(k) Remote turret controls when remote turret is provided
(l) Light switches
(m) Windshield wiper and washer controls
(n) Heater-defroster controls
(o) Master electrical switch
(p) Engine start/stop control.

3-11.5 Equipment.

3-11.5.1 The following minimum equipment shall be provided in or on the cab, as may be applicable:

(a) Heater/defroster

b) Driver's suspension seat with vertical, fore, and aft adjustment, with seat belt

Exception: The use of a nonsuspension driver's seat may be permitted when recommended by the manufacturer.

(c) Crew seats with individual retractable seat belts

(d) Windshield washers appropriate for removing foam

(e) Windshield wipers appropriate for removing foam

(f) Siren

(g) Horn

(h) Sun visors, interior transparent

(i) Outside rear view mirrors, as specified in 3-2.2.4

(j) Interior lighting.

(k) Provisions for mounting SCBA, or the type specified by the purchaser, at each crew seat position.

3-12 Body.

3-12.1 The body shall be constructed of materials that provide the lightest weight consistent with the strength necessary for off-pavement operation over rough terrain and when exposed to excess heat. 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 or wheel wells. Body panels shall be removable where necessary to provide access to the interior of the vehicle.

3-12.2 Access doors shall be provided for those areas of the interior of the vehicle that must be frequently inspected. In particular, access doors of sufficient size and number shall be provided for access to:

(a) Engine

(b) Pump

(c) Foam Proportioning System

(d) Battery Storage

(e) Fluid Reservoirs.

3-12.3 When specified by the purchaser, suitable, lighted compartments shall be provided for storage of equipment and tools to be carried on the vehicle. Compartments shall be weathertight and self-draining.

3-12.4 The working deck of the vehicle shall be adequately reinforced to permit the crew to perform their duties in the turret area, water tank top fill area, foam-liquid top fill area, and in other areas where access to auxiliary or installed equipment is necessary.

3-12.5 Handrails or bulwarks shall be provided where necessary for the safety and convenience of the crew. Rails and stanchions shall be strongly braced and constructed of a material that is durable, resists corrosion, and provides a suitable gripping surface.

3-12.6 Steps or ladders shall be provided for access to the top fill area. The lowermost step(s) may extend below the angle of approach or departure or ground clearance limits if it (they) is (are) designed to swing clear. All other steps shall be rigidly constructed. All steps shall have a nonskid surface. Lowermost step(s) shall be no more than 22 in. (558 mm) above level ground when the vehicle is fully loaded. Adequate lighting shall be provided to illuminate steps and walkways.

3-12.7 A heavy-duty front bumper shall be mounted on the vehicle and secured to the frame structure.

3-12.8 Paint finish shall be selected for maximum visibility and shall be resistant to damage from fire fighting agents.

3-13 Fire Fighting Systems and Agents.

3-13.1 General.

3-13.1.1 For aircraft rescue and fire fighting purposes, AFFF and auxiliary extinguishing agents used shall be listed by a testing laboratory suitable to the authority having jurisdiction. One auxiliary extinguishing agent formulation or one AFFF concentrate shall not be substituted for another without the consent and advice of the agent manufacturer.

3-13.1.2 RIVs designed to discharge AFFF and dry chemical agents shall require use of compatible dry chemical agents.

3-13.1.3 The AFFF system shall be one of the following systems:

(a) Proportioning, meeting requirements specified in 3-13.4

(b) Premixed-pump, meeting requirements specified in 3-13.5

(c) Premixed-pressurized, meeting requirements specified in 3-13.6.

3-13.1.4 All components of the AFFF system including the AFFF liquid tank, piping, fill troughs, screens, etc, shall be made of materials resistant to corrosion by the AFFF liquid concentrate, AFFF/water solution, and water.

3-13.2 Agent Pump(s) and Pump Drive.

3-13.2.1 Agent Pump(s).

3-13.2.1.1 The water pump shall be constructed of corrosion resistant metal(s) 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. The pump shall be gravity primed from the vehicle tank. The pump and piping system shall be designed to eliminate the entrapment of air.

3-13.2.1.2 On those vehicles using a pump discharge side proportioning system, the AFFF liquid pump or pumps shall be made of bronze or other materials resistant to corrosion by AFFF liquid concentrate.

3-13.2.1.3 When discharging foam solution, the pumping system shall be capable of discharging at a rate equal to or exceeding total requirements of turrets, hand line nozzles, and undertruck nozzles discharging simultaneously at designed pressures.

3-13.2.2 Pump(s) Drive.

3-13.2.2.1 The pump(s) drive shall permit operation of the pump(s) and simultaneous operation of the vehicle. The pump(s) shall not be affected by changes in transmission ratios or the actuation of clutches in the vehicle drive. The design of the drive system and controls shall prevent damage to the drive or minimize lurching of the vehicle when the vehicle drive is engaged while pumping operations are in process. The pump(s) drive system shall be capable of absorbing the maximum torque delivered by the engine to the pump(s) and withstand the engagement of the pump(s) at all engine and vehicle speeds and under all operating conditions. The operation of the pump(s) shall not, under any condition, cause the engine to stall or cause more than a slight and momentary reduction in engine speed and consequent drop in pump pressure.

3-13.2.2.2 While pumping at rated capacity, the drive shall permit controlled vehicle operation at speeds from 1 mph to 5 mph. The pump drive shall have sufficient power capacity to provide the pump discharge requirements of 3-13.2.1.3 while the vehicle is being propelled under all operating conditions where a fire fighting capability is required.

3-13.2.2.3 If an independent engine is used to drive the pump, it shall have the same fuel and electrical system as the chassis engine and shall be equipped with an air cleaner, replaceable element oil filter, a full pressure lubricating system, and an overspeed governing device to prevent engine damage. The engine shall also be provided with a cooling system that meets the requirements of 3-3.2.1 or 3-3.2.2.

3-13.2.3 Suction Connections.

3-13.2.3.1 The suction system shall be designed for efficient flow at the pumping rates required by 3-13.2.1.3. The pump suction line(s) 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 corrosion resistant materials.

3-13.2.4 Discharge Connections.

3-13.2.4.1 All discharge outlets shall have National (American) Standard fire hose coupling thread. Adapter couplings, securely attached, shall be provided on each outlet if local couplings are not National (American) Standard as specified in NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections*. No outlet or outlet with adaptors shall add width to the vehicle.

3-13.2.5 Piping, Couplings, and Valves.

3-13.2.5.1 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 galvanic action.

3-13.2.5.2 Piping shall be securely mounted and provided with flexible couplings to minimize stress. Union or rubber gasketed fittings shall be provided where required to facilitate removal of piping.

3-13.2.5.3 All valves shall be quarter-turn type and selected for ease of operating and freedom from leakage.

3-13.2.5.4 All water system piping shall be tested on the suction side of the pump to detect possible leakage. All water and foam solution discharge piping, together with the agent pump(s), shall be tested at 50 percent above system operating pressure.

3-13.2.6 Overheat Protection.

3-13.2.6.1 A system line shall be provided from the water pump discharge and, if applicable, from the foam pump discharge to prevent overheating of the pumps while engaged and operating at zero discharge. The line shall be automatic.

3-13.2.7 Pressure Relief Valves.

3-13.2.7.1 A pressure relief valve shall be fitted both to protect and ensure optimum performance of the system.

3-13.2.8 Drains.

3-13.2.8.1 A drainage system, with collector tubing from the low points on pump(s) and piping shall be provided. The drain shall be provided with a quarter-turn valve.

3-13.3 Water Tank for Nonpressurized Systems.

3-13.3.1 Capacity.

3-13.3.1.1 A water tank shall have a minimum rated capacity of 600 gal (2400 L).

3-13.3.1.2 The rated capacity of the tank shall be equal to the usable capacity that can be pumped from the tank while the vehicle is parked on level ground. The tank outlets shall be arranged to permit use of at least 85 percent of the rated capacity with the vehicle positioned on:

(a) 20 percent side slope

(b) 30 percent ascending grade

(c) 30 percent descending grade.

3-13.3.2 Construction.

3-13.3.2.1 The tank shall be constructed to resist all forms of deterioration that could be caused by the water and foam concentrate while affording the structural integrity required for off-road operation. The tank shall have longitudinal and transverse baffles. The construction and connections shall be made to prevent the possibility of galvanic corrosion of dissimilar metals.

3-13.3.2.2 The tank shall be equipped with easily removable manhole covers over the tank discharge. Tanks shall be designed to permit access within each baffled compartment of the tank for internal and external inspection and service. The tank shall have drain valves.

3-13.3.2.3 Provisions shall be made for necessary overflow and venting. Venting shall be sized to permit agent discharge at the maximum design flow rate without danger

of tank collapse and shall be sized to permit rapid and complete filling without exceeding the internal pressure design limit of the tank. Additionally, overflows shall be designed to prevent the loss of water from the tank during normal maneuvering and to direct the discharge of overflow water directly to the ground.

3-13.3.2.4 The water tank shall be mounted in a manner that limits the transfer of the torsional strains from the chassis frame to the tank during off-pavement driving. The tank shall be separate and distinct from the crew compartment, engine compartment, and chassis and easily removable as a unit.

3-13.3.2.5 The water tank shall be equipped with at least 1 top fill opening of not less than 5 in. (127 mm) internal diameter. The top fill shall be equipped with an easily removable strainer of 1/4-in. (6-mm) mesh construction. The top fill opening shall be equipped with a cap designed to prevent spillage.

3-13.3.3 Tank Fill Connection(s).

3-13.3.3.1 Tank fill connection(s) shall be provided in a position where they can be easily reached from the ground.

3-13.3.3.2 All connections shall have National (American) Standard fire hose coupling threads. Adapters, securely attached, shall be provided on each connection if local couplings are not National (American) Standard. Connections and adapter threads shall be as specified in NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections*. Connections and connections with adapters attached shall not protrude beyond the normal body metal work of the vehicle.

3-13.3.3.3 The connection(s) shall be provided with strainers of 1/4-in. (6-mm) mesh and shall have check valves or be so constructed that water will not be lost from the tank when connection or disconnection is made.

3-13.3.3.4 The tank fill connection(s) shall be sized to permit filling of the water tank in 2 minutes at a pressure of 80 psi (5.5 bar) at the tank intake connection.

3-13.4 AFFF Proportioning System.

3-13.4.1 AFFF Liquid Concentrate Tank.

3-13.4.1.1 The purchaser shall specify the percent concentrate AFFF system to be provided. The AFFF liquid concentrate tank(s) shall have a working capacity sufficient for 2 tanks of water.

3-13.4.1.2 AFFF liquid concentrate tanks may be of either rigid or flexible type. The tank(s) shall be designed for compatability with the AFFF concentrate being used and to resist all forms of deterioration that could be caused by the AFFF concentrate or water.

3-13.4.1.3 The tank shall be designed to provide ready access for internal and external inspection and service. A large capacity drain connection shall be installed flush with the bottom of the sump.

3-13.4.1.4 The tank outlets shall be located above the bottom of the sump and shall provide continuous AFFF liquid concentrate to the AFFF proportioning system, with that system operating as specified in 3-13.4.4 and with the vehicle discharging 2 tank loads of usable water as specified in 3-13.3.1.

3-13.4.1.5 If separate from the water tank, the AFFF liquid tank shall be mounted in a manner that limits the transfer of the torsional strains from the chassis frame to the tank, during off-pavement driving. The tank shall be separate and distinct from the crew compartment, engine compartment, and chassis and shall be easily removable as a unit.

3-13.4.1.5.1 A flexible tank shall be structurally supported to resist tearing. The structural support shall not be dependent on the fluid level in either the water or foam tanks.

3-13.4.1.6 A top fill trough shall be provided equipped with a stainless steel no. 10 mesh screen and container openers to permit emptying 5-gal (20-L) AFFF liquid concentrate containers into the storage tank(s) at a rapid rate regardless of water tank level. The trough shall be connected to the AFFF liquid storage tank(s) with a fill line designed to introduce AFFF liquid concentrate near the bottom of the tank(s) to minimize foaming within the storage tank.

3-13.4.1.7 Tank fill connection(s) shall be provided in a position where they can be easily reached from the ground to permit the pumping of AFFF liquid concentrate into the storage tank(s). The connection(s) shall be provided with strainers of 1/4-in. (6-mm) mesh and shall have check valves or be so constructed that AFFF will not be lost from the tank when connection or disconnection is made.

3-13.4.1.7.1 Where a flexible tank is used, the supply system shall be designed so that the flexible tanks shall not be subject to excess pressure. The supply system shall be capable of delivering AFFF liquid at a rate at least equal to or greater than the maximum discharge rate of the AFFF system.

3-13.4.1.8 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. The vent outlets shall be directed to the ground to prevent spillage of AFFF liquid concentrate on vehicle components.

3-13.4.2 AFFF Liquid Concentrate Pump.

3-13.4.2.1 The AFFF liquid concentrate system shall be so arranged that the entire piping system including the AFFF liquid concentrate pump(s) can be readily flushed with clear water.

3-13.4.2.2 The AFFF liquid concentrate pump(s) shall be capable of delivering the required quantity of AFFF liquid at a pressure in excess of the water pump operating pressure regardless of the water flow rate or variations in engine speed.

3-13.4.3 AFFF Liquid Concentrate Piping.

3-13.4.3.1* The foam-liquid concentrate piping shall be of material resistant to corrosion by AFFF liquid concentrate. Care shall be taken 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 AFFF liquid concentrate. The plastic pipe may be reinforced with glass fibers.

3-13.4.3.2 The AFFF liquid concentrate piping shall be adequately sized to permit the maximum required flow rate and shall be arranged to prevent water from entering the foam tank.

3-13.4.4 AFFF Liquid Proportioning Systems.

3-13.4.4.1 The AFFF concentrate proportioning system shall provide a means of controlling the ratio of AFFF concentrate to the quantity of water in the AFFF solution being discharged from all orifices normally used for aircraft fire fighting operations.

3-13.4.4.2 The proportioning system shall be sufficiently accurate to provide for the discharge of finished foam within the range of 2.8 percent to 3.5 percent foam concentrate in the discharged foam/water solution for a 3 percent concentrate or 5.5 percent to 7.0 percent for a 6 percent concentrate.

3-13.5 AFFF Premixed — Pump System.

3-13.5.1 When premix solution in the main water tank is selected as the means of proportioning foam to water, the foam solution used shall be AFFF only. Care shall be exercised that the premixed solution is mixed to exact proportions. Operation of the vehicle fire fighting system when premix is used shall conform to the requirements of 3-13.2 and 3-13.3 of this standard.

3-13.6 AFFF Premixed — Pressurized System.

3-13.6.1 Liquid Agent Container(s).

3-13.6.1.1 The storage container(s) and liquid agent(s) shall be designed for pressurization and be constructed in accordance with the latest ASME *Boiler and Pressure Vessel Code* and shall be so marked.

3-13.6.1.2 The material of construction shall be resistant to corrosion by the AFFF agent to be stored, or a suitable lining material shall be provided.

3-13.6.1.3 An ASME approved pressure relief valve of adequate capacity shall be provided on the container and set to prevent pressures in excess of the maximum design working pressure. A pressure gage shall be provided that will, at all times, indicate the internal pressure of the agent storage container.

3-13.6.1.4 A readily accessible fill opening of sufficient size to allow ease in filling, and stirring if necessary, shall be provided. It shall be in compliance with ASME or local codes and in no case less than 3 in. (7.6 cm) in diameter. The filling shall be accomplished without the removal of any of the extinguisher piping or any major component.

3-13.6.1.5 A means shall be provided to determine contents of the container as a guide in recharging partial loads.

3-13.6.2 Propellant Gas.

3-13.6.2.1 The propellant gas shall be dry nitrogen or dry compressed air and provided in sufficient quantity to expel the fire fighting agent as well as purge all piping and hose lines after use.

3-13.6.2.2 All propellant gas cylinders and valves shall be in accordance with the U.S. Department of Transportation (DOT) requirements or regulations. Cylinders shall bear the DOT marking.

3-13.6.2.3 The design of the propellant source shall provide for quick and easy replacement after each use.

3-13.6.2.4 A pressure gage shall be provided and shall, at all times, indicate the pressure of the propellant gas source.

3-13.6.2.5 Cylinder valves, gages, and piping shall be arranged as to preclude accidental mechanical injuries.

3-13.6.2.6 The cylinder valve shall be capable of being opened by quick-acting control and shall also be suitable for remote operation.

3-13.6.3 Pressure Regulation.

3-13.6.3.1 Pressure regulation shall be designed to automatically reduce the normal cylinder pressure and hold the propellant gas pressure at the designed operating pressure of the liquid agent container(s).

3-13.6.3.2 All pressure regulating devices shall be sealed or pinned at the designed operating pressures after final adjustment by the system manufacturer.

3-13.6.3.3 Pressure regulating devices shall be equipped with a spring-loaded relief valve that will relieve any excess pressure that may develop in the regulator.

3-13.6.3.4 The pressure regulator may be of a type without pressure indicating gages.

3-13.6.4 Piping and Valves.

3-13.6.4.1 All propellant 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 provide the designed flow of

gas into the system and the minimum amount of restriction from the liquid agent container(s) to all discharge nozzles. Piping and fittings shall be sized and designed to provide simultaneous discharge from the turret(s), undertruck nozzles, and primary hand lines at the rated discharge capacity and range.

3-13.6.4.2 Provisions shall be made for the purging of all piping and hose of the liquid after use without discharging the liquid agent remaining in the container(s). Provisions shall also be made for the depressurization of the liquid agent container without the loss of the remainder of the liquid agent.

3-13.6.4.3 Drains shall be provided to permit complete draining of the system.

3-13.6.4.4 All valves shall be of the quarter-turn, quick-opening, ball type except on the gas cylinder covered in 3-13.6.2.2. A maximum of 2 operations, exclusive of the nozzle, shall be required to charge the system. Controls shall be arranged for simultaneous charging of the liquid agent and dry chemical systems.

3-13.6.4.5 A quick-acting control for operation by the driver to pressurize the liquid agent system from the cab of the vehicle shall be provided with similar control at the unit.

3-13.6.4.6 All valves and piping shall be resistant to corrosion by the AFFF agent.

3-13.6.4.7 A check valve shall be provided in gas piping to prevent the liquid agent from being forced back into the propellant gas line.

3-13.7 Dry Chemical System.

3-13.7.1 General.

3-13.7.1.1 The dry chemical container shall be constructed in accordance with the ASME *Code for Unfired Pressure Vessels* and shall be so stamped.

3-13.7.1.2 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 container 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.

3-13.7.1.3 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 container. Provisions shall also be made for the depressurization of the dry chemical container without the loss of the remainder of the dry chemical. A pressure gage shall be provided that will, at all times, indicate the internal pressure of the agent storage container.

3-13.7.1.4 The system shall be designed to ensure fluidization of the dry chemical at the time of operation. Where any design includes the movement of the chemical container to fluidize the contents, such design shall also include a manual operating feature.

3-13.7.1.5 A check valve shall be provided in the gas piping to prevent the extinguishing agent from being forced back into the propellant gas line.

3-13.7.1.6 A means of pressure relief conforming to appropriate ASME Codes shall be provided for the dry chemical container 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.

3-13.7.1.7 The fill opening in the dry chemical container 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.

3-13.7.1.8 A quick-acting control for operation by the driver to pressurize the dry chemical system from the cab of the vehicle shall be provided with similar control at the hand line.

3-13.7.2 Propellant Gas.

3-13.7.2.1 The propelling agent shall be dry nitrogen or dry air.

3-13.7.2.2 All propellant gas cylinders and valves shall be in accordance with the U.S. Department of Transportion (DOT) requirements or regulations. Cylinders shall bear the DOT marking.

3-13.7.2.3 The method of adequately pressurizing and propelling the dry chemical in the system shall provide a sufficient quantity of gas to expel the agent, as well as permitting the complete purging of all piping and hose lines after each use.

3-13.7.2.4 The design of the propellant source shall provide for quick and easy replacement after each use.

3-13.7.2.5 A pressure gage shall be provided and shall, at all times, indicate the pressure on the propellant gas source.

3-13.7.2.6 Cylinder valves, gages, and piping shall be arranged as to preclude accidental mechanical damage.

3-13.7.3 Pressure Regulation.

3-13.7.3.1 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 container.

3-13.7.3.2 All pressure regulating devices shall be sealed or pinned at the designed operating pressures after final adjustment by the system manufacturer.

3-13.7.3.3 Pressure regulating devices shall be equipped with a spring-loaded relief valve that will relieve any excess pressure that may develop in the regulator.

3-13.7.3.4 The pressure regulator may be of a type without pressure indicating gages.

3-13.8 Halon 1211 System.

3-13.8.1 Halon Container.

3-13.8.1.1 The storage container shall be designed for pressurization and shall be constructed in accordance with the ASME *Code for Unfired Pressure Vessels* and shall be so marked.

3-13.8.1.2 The material of construction shall be resistant to corrosion by the Halon agent to be stored.

3-13.8.1.3 A readily accessible charge coupling of sufficient size to allow ease in filling shall be provided. The filling shall be accomplished without the removal of any of the extinguisher piping or any major component. A pressure gage shall be provided that will, at all times, indicate the internal pressure of the agent storage container.

3-13.8.1.4 A means shall be provided to determine contents of the container as a guide in recharging partial loads and to prevent overfilling of the tank.

3-13.8.2 Propellant Gas.

3-13.8.2.1 The propellant gas shall be dry nitrogen or dry compressed air and provided in sufficient quantity to expel the Halon agent as well as purge all piping and hose lines after use.

3-13.8.2.2 All propellant gas cylinders and valves shall be in accordance with the U.S. Department of Transportation (DOT) requirements or regulations. Cylinders shall bear the DOT marking.

3-13.8.2.3 Connecting pipes and valves to the Halon container shall conform to the appropriate ASME Code and be designed to withstand the working pressure of the system.

3-13.8.2.4 The design of the propellant source shall be such that it will provide a quick and easy replacement after each use.

3-13.8.2.5 A pressure gage shall be provided that will, at all times, indicate the pressure on the propellant gas source.

3-13.8.2.6 Cylinder valves, gages, and piping shall be arranged as to preclude accidental mechanical injuries.

3-13.8.2.7 A check valve shall be provided in gas piping to prevent the liquid agent from being forced back into the propellant gas line.

3-13.8.3 Pressure Regulation.

3-13.8.3.1 An ASME approved pressure relief valve of adequate capacity shall be provided on the container and shall be set to prevent pressures in excess of the maximum design working pressure.

3-13.8.3.2 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 Halon container(s).

3-13.8.3.3 All pressure regulating devices shall be sealed or pinned at the designed operating pressures after final adjustment by the system manufacturer.

3-13.8.3.4 Pressure regulating devices shall be equipped with a spring-loaded relief valve that will relieve any excess pressure that may develop in the regulator.

3-13.8.3.5 The pressure regulator may be of a type without pressure indicating gages.

3-13.8.4 Halon Delivery Piping and Valves.

3-13.8.4.1 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 galvanic action. Piping shall be securely mounted and provided with flexible couplings to minimize stress.

3-13.8.4.2 All valves shall be quarter-turn type and selected for ease of operating and freedom from leakage.

3-13.8.4.3 All discharge piping shall be tested at 50 percent above system operating pressure.

3-13.8.4.4 When more than 1 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.

3-13.8.4.5 Provisions shall be made for the purging of all piping and hose of the Halon after use without discharging the Halon remaining in the container(s). Provisions shall also be made for venting of the Halon container without the loss of the remainder of the liquid agent.

3-13.8.4.6 A quick-acting control for operation by the driver to pressurize the Halon system from the cab of the vehicle shall be provided with similar control at the hand line.

3-13.9 Turret Nozzles.

3-13.9.1 The RIV shall have an AFFF turret.

3-13.9.1.1 When dry chemical is the specified auxiliary extinguishing agent, a turret shall be provided for dry chemical agent application and such turret may be separate or twinned with the AFFF turret.

3-13.9.1.2* When Halon is the specified auxiliary extinguishing agent, no turret shall be required but minimum of 1 hand line shall be provided for Halon agent application.

3-13.9.2 The nominal AFFF solution discharge rate in gpm (L/min) from the AFFF turret shall be equal to the rated capacity of the water tank. The roof turret discharge rates shall have a tolerance of −0% or +10%.

3-13.9.3 AFFF turrets shall be capable of discharging AFFF in still air in a continuously variable pattern with the turret elevated to the maximum stream reach position, to the following criteria:

Straight Stream Minimum Far Point	Dispersed Stream Minimum Range	
	Width	Far Point
165 ft (50 m)	35 ft (10.6 m)	60 ft (18.2 m)

3-13.9.4 The dry chemical turret, when provided, shall be designed to dispense the dry chemical agent at a minimum discharge rate of 16 lb/sec, and with a minimum far point range of not less than 100 ft (30 m) with a pattern width not less than 17 ft (5 m) with turret stationary.

3-13.9.5 Turrets shall be remotely controlled from the cab and may be manually or power operated. Turret remote control operating forces shall be less than 30 lb (13.5 kgf), and cab indication of turret elevation and azimuth shall be provided.

3-13.9.6 Turrets shall be capable of being elevated at least 45° above the horizontal and depressed to discharge agent within 30 ft in front of the vehicle at full output using dispersed stream. Where a single turret is used on a vehicle, it shall be capable of being rotated not less than 90° to either side, total traverse not less than 180°.

3-13.10 Hand Lines, Reels, and Nozzles.

3-13.10.1 RIVs shall have a minimum of 1 primary hand line and nozzle for each agent. Hand lines and nozzles may be separate or twinned together for simultaneous agent discharge. Hand lines may be reeled hand lines specified in 3-13.10.2 or woven jacket hose lines specified in 3-13.10.3.

3-13.10.2 Reeled Hand Lines.

3-13.10.2.1 Hand lines for reels shall have a minimum internal diameter of 1 inch, shall have a minimum burst pressure rating at least 3 times greater than the nominal working pressure of the system, and shall be able to discharge the gpm (L/min) required in 3-13.10.2.3 without unreeling the hose.

3-13.10.2.2 At least 100 ft (30 m) of hose shall be provided for each reel.

3-13.10.2.3 Each hand line shall be equipped with a shutoff type nozzle designed to discharge both foam and water at a nominal discharge rate of 60 gpm (240 L/min) ±5 percent. Each nozzle shall have minimum foam discharge patterns from a dispersed stream of 15 ft (4.5 m) width and 20 ft (6 m) range to a straight foam stream with a 50 ft (15 m) range.

3-13.10.2.4 Each reel shall have capacity for at least 100 ft (30 m) of 1-inch hose or more if specified by the purchaser.

3-13.10.2.5 Each reel shall be designed and positioned to permit hose line removal by a single person from any position in a 120° horizontal sector. Each reel shall be equipped with a friction brake to prevent hose from unreeling when not desired. Power rewind with manual override shall be provided. The nozzle holder, friction brake, rewind controls, and manual valve control shall be accessible from the ground.

3-13.10.2.6 Flow to each hand line shall be controlled by a manually operated, quarter-turn, ball-type valve, located adjacent to the hand line.

3-13.10.3 Woven Jacket Hand Lines.

3-13.10.3.1 Woven jacket hose lines shall have a minimum diameter of 1½ in. (38 mm) and shall meet the requirements of NFPA 1961, *Standard for Fire Hose.*

3-13.10.3.2 At least 150 ft (45 m) of hose shall be provided each hand line.

3-13.10.3.3 Each hand line shall be equipped with a shutoff type nozzle designed to discharge both foam and water at a nominal discharge rate of 95 gpm (380 L/min) ±5 percent. Each nozzle shall have minimum foam discharge patterns from a dispersed stream of 15 ft (4.5 m) width and 20 ft (6 m) range to a straight foam stream with a 65 ft (19.8 m) range.

3-13.10.3.4 Each hand line shall be stored, flat loaded, in a hose compartment and shall be preconnected. Each hose compartment shall have a capacity for a minimum of 150 ft (45 m) of 1½-in. (38-mm) multiple jacket hose or more if specified by the purchaser.

3-13.10.3.5 Hose compartments shall be fabricated from noncorrosive material and shall be designed to drain effectively. The compartment shall be smooth and free from all projections that might damage hose. No other equipment shall be mounted or located where it will obstruct the removal of the hose. The hose compartment shall not be more than 5½ ft (1.6 m) above the ground.

3-13.10.4 Auxiliary Agent Hand Lines.

3-13.10.4.1 Hand lines for auxiliary agents shall have a minimum burst pressure rating of at least 3 times greater than the nominal working pressure of the system and shall meet the requirements of paragraphs 3-13.10.2 or 3-13.10.3. The auxiliary agent hand line shall be equipped with a nozzle that allows full open to closed position in one simple movement and shall be designed to discharge agent

at a minimum rate of 5 lb (2.2 kg) per second at a minimum range of 20 ft (6 m). Nozzle construction shall be of nonferrous metal or stainless steel.

3-13.10.4.2 Twinned hand lines and nozzles shall be designed so that each agent may be discharged separately or simultaneously. The barrels shall be linked together to provide coordinated application by one operator.

3-13.11 Foam Quality.

3-13.11.1 Turrets and hand lines shall discharge AFFF having the following quality:

	Air-aspirating Nozzles		Nonair-aspirating Nozzles	
	Minimum Expansion Ratio	Minimum 25 percent Drainage, in Minutes	Minimum Expansion Ratio	Minimum 25 percent Drainage, in Minutes
Turrets	5	4	3	1
Hand lines	5	4	3	1

Measurement of expansion ratio and 25 percent drainage times shall be in accordance with the procedures outlined in NFPA 412, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles.*

3-13.12 Undertruck Nozzles.

3-13.12.1 Two or more undertruck nozzles shall be mounted under the truck and controlled from the cab. A sufficient number shall be provided to protect the bottom of the vehicle and the inner sides of the wheels and tires with foam solution discharged in a spray pattern.

3-14 Lighting and Electrical Equipment.

3-14.1 Lighting equipment shall be installed in conformity with local road regulations when practicable and shall include the following:

(a) Headlights with upper and lower driving beams. A control switch, that is readily accessible to the driver, shall be provided for beam selection.

(b) Dual taillights and stoplights.

(c) Turn signals, front and rear, with a steering column mounted control and a visual and audible indicator. A 4-way flasher switch shall be provided.

(d) Spotlight, 6-in. (152-mm) minimum on both left and right sides of the windshield, hand adjustable type, with controls for beam adjustment inside the truck cab.

(e) Adequate reflectors, and marker and clearance light, shall be furnished to describe the overall length and width of the vehicle.

(f) Engine compartment lights, nonglare type, arranged to illuminate both sides of the engine with individual switches located in the engine compartment.

(g) Lighting shall be provided for all top deck working areas.

(h) At least 1 back-up light and an audible alarm installed in the rear of the body.

(i) 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 the 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.

3-14.2* A warning siren shall be provided having a sound output of not less than 95 decibels at 100 ft (30 m) directly ahead of the siren and not less than 90 decibels at 100 ft (30 m) measured at 45° 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.

3-14.3 A horn shall be provided and shall be mounted at the front part of the vehicle with the control positioned such that it is readily accessible to the driver.

3-14.4 Radios.

3-14.4.1 Provision shall be made for mounting radios. Operation of the radios shall be from the cab. Radios shall be mounted permitting quick servicing or replacement.

3-14.4.2 Purchaser shall specify radios that will ensure that all required radios and frequencies are provided for.

3-15 Tools.

3-15.1* Provision shall be made for mounting on the truck, tools, and equipment specified by the purchaser. Special tools as required for servicing the vehicle, servicing the fire suppression system, and servicing the auxiliary equipment shall be furnished by the vehicle manufacturer.

Chapter 4 Combined Agent Vehicles

4-1 General.

4-1.1 The category of "Combined Agent Vehicles" shall encompass the range of water capacity commencing at 100 gal (400 L) and extending to 350 gal (1400 L). In addition to carrying foam as a primary agent, either dry chemical or Halon 1211 extinguishing agent shall also be carried as an auxiliary agent.

4-1.2 The following quantities of water and auxiliary agent shall establish the class of vehicle:

	Minimum Water Capacity		Minimum Auxiliary Agent	
Class	Gal	(L)	lb	(kg)
1	100	(400)	100	(45)
2	200	(800)	200	(90)
3	350	(1400)	300	(135)

4-2 Weights and Dimensions.

4-2.1 Weights.

4-2.1.1 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.

4-2.1.2 The weight shall be distributed as equally as practical over the axles and tires of the fully loaded vehicle. The difference in weight between tires on any 1 axle shall not exceed 5 percent of that axle weight, and the difference in weight between axles shall not exceed 10 percent of the weight of the heaviest axle. The front axle shall not be the heaviest axle. Under no circumstances shall axle and tire manufacturer's ratings be exceeded.

4-2.1.3 Center of gravity of the vehicle shall be kept as low as possible under all conditions of loading. The vehicle shall be capable of operations on a 20 percent sideways slope in both directions and shall be capable of ascending and descending a 50 percent grade in forward gear.

4-2.2 Dimensions.

4-2.2.1 Underchassis clearance of the vehicle shall permit mobility in soft soils and rough terrain. The following shall be minimum dimensions:

Angle of Approach — 30°

Angle of Departure — 30°

Interaxle Clearance Angle — 12°

Underaxle Clearance — 8 in. (203 mm) under axle differential housing bowl.

4-2.2.2* Overall height, length, and width of the vehicle shall be held to a minimum consistent with the best operational performance of the vehicle and the design concepts needed to achieve this performance and to provide optimum maneuverability and facilitate movement on public highways.

4-2.2.3 The vehicle shall be constructed such that a seated driver, having an eye reference point of 31¾ in. (805 mm) above the seat cushion and 12 in. (30.5 cm) forward from the seat back, shall be able to see the ground 20 ft (6 m) ahead of the vehicle and have vision of at least 5° above the horizontal plane. The vision in the horizontal plane shall be at least 90° on each side from the straight ahead position.

4-2.2.4 Adjustable rear view mirrors with a glass area of not less than 60 sq in. (385 cm^2) shall be provided on each side of the vehicle. Each shall be provided with a minimum of 7 sq in. area (45.2 cm^2) wide angle (convex) mirror.

4-3 Engine.

4-3.1 Performance Requirements.

4-3.1.1 The vehicle engines shall have horsepower, torque, and speed characteristics to meet and maintain all specified vehicular performance characteristics specified in this standard. The engine manufacturer shall certify that the installed engine is approved for this application.

4-3.1.2* The fully loaded vehicle shall consistently be able to accelerate from 0-50 mph (0-80 km/h) on dry, level concrete pavement at the operational airport within the times specified in Table 4-3.1.2. Maximum speed shall not be less than 65 mph (104 km/h).

Table 4-3.1.2

Vehicle Class	Maximum Acceleration Time 0-50 mph (0-80 km/h) in Seconds
1	25
2	30
3	30

The above acceleration times shall be achieved with the engine and transmission at their normal operating temperature at any temperature varying from 0°F (−18°C) to 110°F (43°C) and at elevations up to 2,000 ft (609 m) above sea level unless a higher elevation is specified.

Airports above 2,000 ft (609 m) shall state the elevation at which the vehicle will operate in order to ensure the required performance.

4-3.1.3 Where the engine is used to power both the vehicle and a fire fighting pump, provision shall be made to ensure that the operation of the pump will not:

(a) Cause the engine to stall;

(b) Allow the recommended pump speed to be exceeded.

4-3.2 Engine Cooling Systems.

4-3.2.1 Liquid Cooled Engines.

4-3.2.1.1 The cooling system shall be designed so that the stabilized engine coolant temperature remains within the engine manufacturer's prescribed limits under all operational conditions and at all ambient temperatures encountered at the operational airport. The cooling system shall be provided with automatic thermostat for rapid engine warming.

4-3.2.1.2 Radiator shutters, when furnished for cold climates, shall be of the automatic type and shall be designed to open automatically upon failure.

4-3.2.2 Air-Cooled Engines.

4-3.2.2.1 Air-cooled engines shall be designed so that the stabilized cylinder head and oil temperatures remain within the engine manufacturer's prescribed limits under all operational conditions and at all ambient temperatures encountered at the operational airport.

4-3.3 Fuel System.

4-3.3.1 A complete fuel system, requiring engine manufacturer's installation approval, shall include a fuel pump, fuel filtration, and flexible fuel lines where necessary that shall be protected from damage, exhaust heat, and exposure to ground fires. Gasoline engines shall have an electric fuel pump located near the fuel tank to prevent vapor lock.

4-3.3.2 Accessible filtration shall be provided for each fuel supply line, and a drain shall be provided at the bottom of the fuel tank.

4-3.3.3 Fuel tanks shall not be installed in a manner that permits gravity feed.

4-3.3.4 Fuel tanks shall have a minimum capacity of 18 gal (72 L).

4-3.4 Exhaust System.

4-3.4.1 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 system shall be of high grade, rust resistant materials.

4-3.4.2 The tailpipe and muffler shall be protected from damage that could result from traversing rough terrain. Tailpipe shall be designed to discharge upward or to the rear and shall not be directed toward the ground.

4-4 Vehicle Electrical System.

4-4.1 The engine shall be equipped with a complete battery starting system.

4-4.2 A complete 12 volt, negative electrical system including transistorized alternator and fully transistorized voltage regulator shall be furnished. The idle minimum charging rate shall be 30 amp. The alternator shall be driven by dual belts.

4-4.2.1 When specified by the purchaser, a complete 24 volt, negative ground electrical system including transistorized alternator and fully transistorized voltage regulator may be furnished. The alternator shall be rated at 100 percent of anticipated load at 50 percent engine governed speed. The curb idle minimum charging rate shall be 15 amp. The alternator shall be driven by dual belts.

4-4.3 Batteries shall be securely mounted and adequately protected against physical injury and vibration, water spray, and engine and exhaust heat. When an enclosed battery compartment is provided, it shall be adequately ventilated and the batteries shall be readily accessible for examination, test, and maintenance.

4-4.4 Battery capacity shall be commensurate with size of the engine and the anticipated electrical load. Capacity shall be not less than 120 amp-hr rating at a 20-hr discharge rate (520 cold cranking amps) for gasoline engines and 200 amp-hr rating at a 20-hr discharge rate (900 cold cranking amps) for diesel engines using 12-volt starting systems. One or more polarized receptacles shall be provided for charging all batteries.

4-4.5 The battery capacity and wiring circuits provided, including the starter switch and circuit and the starter to the battery connections, shall meet or exceed the engine manufacturer's recommendations.

4-4.6 An engine coolant preheating device shall be provided as an aid to rapid starting and high initial engine performance.

4-4.7 The electrical system shall be insulated, waterproofed, and protected against exposure from ground fires. All wiring shall be coded in some manner to correspond with the wiring diagram provided with the vehicle. Circuit protection shall be provided to protect the vehicle in the event of electrical overload.

4-4.8 Radio suppression of the electrical system shall be in accordance with SAE J551, *Standard on Performance Levels and Methods of Measurement of Electromagnetic Radiation from Vehicles and Devices (20-1000 MHz)* or equivalent radio suppression standard.

4-5 Vehicle Drive.

4-5.1 Transmission of power from the engine to the wheels of the vehicle shall be through a torque converter and automatic or semi-automatic gearbox. The entire drive train shall be designed and rated by the component manufacturer as having sufficient capacity to slip the wheels of the static loaded vehicle on a surface having a coefficient of friction of 0.8. A range of gears providing the specified top speed and a grade ability of 50 percent shall be provided with sufficient intermediate gears to achieve the specified acceleration.

4-5.2 The provision of positive drive to each wheel by means of a fully locked driveline shall be required in order to maximize traction on low friction surfaces. Positive drive may be achieved either by the use of automatic locking and torque proportioning differentials or may be manually selectable by the seated driver, while the vehicle is in motion, by use of a single control.

4-5.3 All-wheel drive on these vehicles shall incorporate a drive to the front and rear axles that is engaged at all times during the intended airport service. An interaxle differential shall be installed with automatic or driver selected means of differential locking.

4-5.4 All traction increasing devices shall be operated by a single control for driving simplicity.

4-5.5 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 percent of the tire sectional width at rated load.

4-6 Suspension.

4-6.1 The suspension system shall be designed to permit the loaded vehicle to:

(a) travel at the specified speeds over improved surface;

(b) travel at moderate speeds over unimproved surface;

(c) provide diagonally opposite wheel motion 10 in. above ground obstacles without raising the remaining wheels from the ground;

(d) prevent damage to the vehicle caused by wheel movement; and

(e) provide a good environment for the crew when traveling over all surfaces.

4-7 Wheels, Tires, and Rims.

4-7.1 Vehicles shall be required to have off-highway mobility while meeting the specified paved surface performance.

4-7.2 Tires shall be selected to maximize the acceleration, speed, braking, and maneuvering capabilities of the vehicle on paved surfaces without sacrificing performance on all reasonable terrains found within the airport boundary.

4-7.3* The purchaser shall provide a tire description that reflects the off-road performance requirements necessitated by the soil conditions encountered at the operational airport. Soil conditions that may vary from an extremely fine grain soil or clay to an extremely coarse grain soil, sand, or gravel in a dry, saturated, or frozen condition shall be considered.

To optimize flotation under soft ground conditions, tires of larger diameter or width, or both, than are needed for weight carrying alone shall be specified. Similarly, the lowest tire pressure compatible with the high speed performance requirements shall also be specified.

4-7.4 Vehicle and tire manufacturers shall be consulted for tread design most suitable for specific soil composition at individual airports.

4-7.5 All wheels on the vehicle shall be of the single wheel type with all rims, tires, and wheels of identical size and same tire tread design.

4-7.6 Rims, tires, wheels, and inflation pressures shall be approved by the respective manufacturers as having sufficient capacity to meet the specified performance, and shall be certified for not less than 5 mi (8 km) of continuous operation at 65 mph (100 km/h) at normal operational pressure.

4-8 Towing Connections.

4-8.1 Four large tow eyes or tow hooks capable of towing the vehicle on level ground without damage shall be mounted, 2 at the front and 2 at the rear of the truck, and attached directly to the frame structure. Recovery of the vehicle from adverse conditions shall be made by attaching to the axles.

4-9 Brakes.

4-9.1* Service brakes shall be of the all-wheel type. Service brakes may be of the hydraulic type with power booster or the air-mechanical type.

4-9.2 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 bowl.

4-9.3 Air brake systems shall include a compressor, automatic air drying system immediately downstream from the compressor to prevent condensation buildup in all pneumatic lines, release valve, brake control valve, treadle-type actuating pedal, air pressure gage, enclosed-type brake adjusters, low pressure warning, and all necessary connections.

4-9.4 Compressor for air brakes shall have a minimum capacity of 7 cu ft/min (.003 m^3/sec).

4-9.5 Compressed air reservoirs shall have a minimum capacity of 2,000 cu in. and shall be equipped with drain and safety valves. Quick buildup of air pressure for release of parking brakes and 1 full service brake application shall be accomplished within 12 seconds.

4-9.6 The service brakes shall be capable of holding the fully loaded vehicle on a 50 percent grade and capable of bringing the fully loaded vehicle to 5 complete successive stops within 35 feet (10.6 m) from a speed of 20 mph (32 km/h) on dry, hard, approximately level road, free from loose material.

4-9.7 The parking 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.

4-9.8 The parking brake shall be capable of holding the fully loaded vehicle on a 20 percent grade.

4-10 Steering.

4-10.1 The chassis shall be equipped with power-assisted steering with direct mechanical linkage from the steering wheel to the steered axle(s) to permit the possibility of manual control in the event of power assist failure.

4-10.2 The power steering system shall have sufficient capacity so that no more than 15 lb pull is required on the steering wheel rim in order to turn the steering linkage from stop to stop with the fully loaded vehicle stationary on a dry, level, paved surface with the engine at idle.

4-10.3 The wall-to-wall turning diameter of the fully loaded vehicle shall be less than 3 times the vehicle length.

4-11 Cab.

4-11.1 The cab shall be fully enclosed (floor, roof, and 4 sides) and mounted on the forward part of the vehicle. Crew seating positions shall be restricted to the cab. The maximum number of crew seat positions provided in the cab shall be designated by the manufacturer and so labeled in the cab. As a minimum, 1 designated seat position shall be provided for the driver and 1 additional crew member. Seat belts, approved by the authority having jurisdiction, shall be provided for each of the designated seating positions. Space shall be provided for all instrument controls and equipment specified without hindering the crew. Wide opening doors shall be provided on each side of the cab with the necessary steps and handrails to permit rapid and safe entrance and exit from the cab. Cab design shall take into consideration the provision of ample space for the crew to enter and exit the cab and carry out normal operations while wearing full protective equipment.

4-11.2 The cab shall meet the visibility requirements of 4-2.2.3. Interior cab reflections from exterior and interior lighting shall be minimized. The windshield shall be shatterproof safety glass, and all other windows shall be constructed of approved safety glass. The cab shall be provided with wide gutters to prevent foam and water

dripping on the windshield and side windows. When equipped with a roof turret having manual controls above the cab roof, the cab shall be designed with a quick-access passage to the roof turret(s).

4-11.3 The cab shall be weatherproof, and shall be fully insulated thermally and acoustically with a fire resistant material.The cab interior noise level at the driver's ear position shall not exceed 90 dBA while traveling at 50 mph (80.5 km/hr) on a level hard surface. This noise level will be achieved with the agent, communication, audible warning, and emergency warning systems inactive. The cab may be of the unitized rigid body and frame structure type or it may be a separate unit flexibly mounted on the main vehicle frame. The cab shall be constructed from materials of adequate strength to ensure a high degree of safety for the crew under all operating conditions including excess heat exposure, and in the event of a vehicle rollover accident.

4-11.4 Instruments, Warning Lights, and Controls.

4-11.4.1 The minimum number of instruments, warning lights, and controls consistent with the safe and efficient operation of the vehicle chassis and fire fighting system shall be provided. All chassis instruments and warning lights shall be grouped together on a panel immediately in front of the driver. All fire fighting system instruments, warning lights, and controls shall be grouped together by function so as to provide ready accessibility as well as high visibility for the driver as well as a crew member.

4-11.4.2 All instruments and controls shall be illuminated, with backlighting to be used where practical.

4-11.4.3 Groupings of both the chassis and fire fighting system instruments, warning lights, and controls shall be easily removable as a unit or be on a panel hinged for back access by the use of quick disconnect fittings for all electrical, air, and hydraulic circuits.

4-11.4.4 The following instruments or warning lights, or both, shall be provided as a minimum:

(a) Speedometer/odometer
(b) Engine tachometer(s)specified
(c) Fuel level
(d) Air pressure, when specified
(e) Engine(s) temperature
(f) Pump pressure, when specified
(g) Water tank level, when specified
(h) Foam-liquid tank level, when specified
(i) Low air pressure warning, when specified
(j) Headlight beam indicator
(k) Engine(s) oil pressure
(l) Voltmeter(s)
(m) Transmission oil temperature.

4-11.4.5 The cab shall have all the necessary controls within easy reach of the driver for the full operation of the vehicle and for activating the fire fighting system. The following cab controls shall be provided as applicable:

(a) Accelerator pedal
(b) Brake pedal
(c) Parking brake control
(d) Steering wheel, with self-cancelling directional control signal and horn
(e) Transmission range selector
(f) Pump control or liquid agent pressurization control
(g) Liquid agent tank valve control
(h) Siren switch(es)
(i) Ignition switch(es)
(j) Auxiliary agent pressurization control
(k) Remote turret, only when remote turret is furnished
(l) Starter switch(es)
(m) Light switches
(n) Windshield wiper and washer controls
(o) Heater-defroster controls.

4-11.5 Equipment.

4-11.5.1 The following equipment shall be provided in or on the cab, as may be applicable:

(a) Heater/defroster

(b) Driver's seat with fore and aft adjustment, with seat belt

(c) Crew seats with individual retractable seat belts

(d) Windshield washers appropriate for removing foam

(e) Windshield wipers appropriate for removing foam

(f) Siren

(g) Horn

(h) Sun visors

(i) Outside rear view mirrors, as specified in 4-2.2.4

(j) Interior lighting

(k) Provisions for mounting SCBA, of the type specified by the purchaser, at each crew seat position.

4-12 Body.

4-12.1 The body shall be constructed of materials that provide the lightest weight consistent with the strength necessary for off-pavement operation over rough terrain and when exposed to excess heat. 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 or wheel wells. Body panels shall be removable where necessary to provide access to the interior of the vehicle.

4-12.2 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:

(a) Engine

(b) Pump

(c) Battery Storage

(d) Fluid Reservoirs

(e) Foam System.

Other areas requiring access for inspection or maintenance shall either be open or have removable panels.

4-12.3 Suitable, lighted compartments shall be provided for convenient storage of equipment and tools to be carried on the vehicle. Compartment doors shall be operable for hands covered with bulky gloves. Compartments shall be weathertight and self-draining.

4-12.4 The working deck of the vehicle shall be adequately reinforced to permit the crew to perform their duties in all areas where access to auxiliary or installed equipment is necessary.

4-12.5 Handrails or bulwarks shall be provided where necessary for the safety and convenience of the crew. Rails and stanchions shall be strongly braced and constructed of a material that is durable, resists corrosion, and provides a suitable gripping surface.

4-12.6 Steps or ladders shall be provided for access to the top fill area. All lowermost step(s) may extend below the angle of approach or departure or ground clearance limits if they are designed to swing clear. All other steps shall be rigidly constructed. All steps shall have a nonskid surface. Lowermost step(s) shall be no more than 22 in. (558 mm) above level ground when the vehicle is fully loaded. Adequate lighting shall be provided to illuminate steps and walkways.

4-12.7 A heavy-duty front bumper shall be mounted on the vehicle and secured to the frame structure.

4-12.8 Paint finish shall be selected for maximum visibility and shall be resistant to damage from fire fighting agents.

4-13 Fire Fighting Systems and Agents.

4-13.1 General.

4-13.1.1 For aircraft rescue and fire fighting purposes, foams and dry chemicals used shall be listed by a testing laboratory suitable to the authority having jurisdiction. One dry chemical formulation or one foam concentrate shall not be substituted for another without the consent and advice of the agent manufacturer.

4-13.1.2 Combined agent vehicles designed to simultaneously discharge foam and dry chemical agents, through twinned turrets or hand lines, shall require use of AFFF and potassium bicarbonate based dry chemical agent only.

4-13.1.3 The foam system shall be one of the following systems:

(a) Proportioning, meeting requirements specified in 4-13.4

(b) Premixed-pump, meeting requirements specified in 4-13.5

(c) Premixed-pressurized, meeting requirements specified in 4-13.6.

4-13.1.4 All components of the foam system including the foam-liquid tank, piping, fill troughs, screens, etc., shall be made of materials resistant to corrosion by the foam-liquid concentrate, foam/water solution, and water.

4-13.2 Pump and Pump Drive.

4-13.2.1 Water Pump.

4-13.2.1.1 The water pump shall be constructed of corrosion-resistant metals 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. The pump shall be gravity primed from the vehicle tank. The pump and piping system shall be designed to eliminate the entrapment of air.

4-13.2.1.2 When discharging foam solution, the pump shall be capable of discharging at a rate equal to or exceeding total requirements of turrets and hand line nozzles discharging simultaneously at designed pressures.

4-13.2.2 Pump Drive.

4-13.2.2.1 The pump(s) drive shall permit operation of the pump(s) and simultaneous operation of the vehicle. The pump(s) shall not be affected by changes in transmission ratios or the actuation of clutches in the vehicle drive. The design of the drive system and controls shall prevent damage to the drive or minimize lurching of the vehicle when the vehicle drive is engaged while pumping operations are in process. The pump(s) drive system shall be capable of absorbing the maximum torque delivered by the engine to the pump(s) and withstanding the engagement of the pump(s) at all engine speeds and under operating conditions. The operation of the pump(s) shall not, under any condition, cause the engine to stall or cause more than a slight and momentary reduction in engine speed and consequent drop in pump pressure.

4-13.2.2.2 While pumping at rated capacity, the drive shall permit controlled vehicle operation at speeds from 1 mph to 5 mph. The pump drive shall have sufficient power capacity to provide the pump discharge requirements of 4-13.2.1.2 while the vehicle is being propelled under all operating conditions where a fire fighting capability is required.

4-13.2.2.3 If an independent engine is used to drive the pump, it shall have the same fuel and electrical system as the chassis engine and shall be equipped with an air cleaner, replaceable element oil filter, a full pressure lubricating system and an overspeed governing device to prevent engine damage. The engine shall also be provided with a cooling system that meets the requirements of 4-3.2.1 or 4-3.2.2.

4-13.2.3 Suction Connections.

4-13.2.3.1 The suction system shall be designed for efficient flow at the pumping rates required by 4-13.2.1.2. The pump suction line(s) 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 corrosion resistant materials.

4-13.2.4 Discharge Connections.

4-13.2.4.1 All discharge outlets shall have National (American) Standard fire hose coupling thread. Adapter couplings, securely attached, shall be provided on each outlet if local couplings are not National (American) Standard as specified in NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections*.

4-13.2.5 Piping, Couplings, and Valves.

4-13.2.5.1 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 galvanic action.

4-13.2.5.2 Piping shall be securely mounted and provided with flexible couplings to minimize stress. Union or rubber gasketed fittings shall be provided where required to facilitate removal of piping.

4-13.2.5.3 All valves shall be quarter-turn type and selected for ease of operating and freedom from leakage.

4-13.2.5.4 All water system piping shall be tested on the suction side of the pump to detect possible leakage. All water and foam solution discharge piping, together with the agent pump(s), shall be tested at 50 percent above system operating pressure.

4-13.2.6 Overheat Protection.

4-13.2.6.1 A system line shall be provided from the water pump discharge and, if applicable, from the foam pump discharge to prevent overheating of the pumps while engaged and operating at zero discharge. The line shall be automatic.

4-13.2.7 Pressure Relief Valves.

4-13.2.7.1 A pressure relief valve shall be fitted both to protect and ensure optimum performance of the system.

4-13.3 Water Tank for Nonpressurized Systems.

4-13.3.1 Capacity.

4-13.3.1.1 A water tank shall have a usable capacity as specified in 4-1.2.

4-13.3.1.2 The rated capacity of the tank shall be equal to the usable capacity that can be pumped from the tank while the vehicle is parked on level ground. The tank outlets shall be arranged to permit use of at least 85 percent of the rated capacity with the vehicle positioned on:

(a) 20 percent side slope
(b) 30 percent ascending grade
(c) 30 percent descending grade.

4-13.3.2 Construction.

4-13.3.2.1 The tank shall be constructed to resist all forms of deterioration that could be caused by the water and foam concentrate while affording the structural integrity required for off-road operation. The tank shall have longitudinal and transverse baffles. The construction and connections shall be made to prevent the possibility of galvanic corrosion of dissimilar metals.

4-13.3.2.2 The tank shall be equipped with easily removeable manhole covers over the tank discharge. Tanks shall be designed to permit access within each baffled compartment of the tank for internal and external inspection and service. The tank shall have drain valves.

4-13.3.2.3 Provisions shall be made for necessary overflow and venting. Venting shall be sized to permit agent discharge at the maximum design flow rate without danger of tank collapse and shall be sized to permit rapid and complete filling without exceeding the internal pressure design limit of the tank. Additionally, overflows shall be designed to prevent the loss of water from the tank during normal maneuvering and to direct the discharge of overflow water directly to the ground.

4-13.3.2.4 The water tank shall be mounted in a manner that limits the transfer of the torsional strains from the chassis frame to the tank during off-pavement driving. The tank shall be separate and distinct from the crew compartment, engine compartment, and chassis and easily removable as a unit.

4-13.3.2.5 The water tank shall be equipped with at least 1 top fill opening of not less than 5 in. (127 mm) internal diameter. The top fill shall be equipped with an easily removable strainer of 1/4-in. (6-mm) mesh construction. The top fill opening shall be equipped with a cap designed to prevent spillage.

4-13.3.3 Tank Fill Connection(s).

4-13.3.3.1 Tank fill connection(s) shall be provided in a position where they can be easily reached from the ground.

4-13.3.3.2 All connections shall have National (American) Standard fire hose coupling threads. Adapters, securely attached, shall be provided on each connection if local couplings are not National (American) Standard. Connections and adapter threads shall be as specified in NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections*. Connections and connections with adapters attached shall not protrude beyond the normal body metal work of the vehicle.

4-13.3.3.3 The connection(s) shall be provided with strainers of 1/4-in. (6-mm) mesh and shall have check valves or be so constructed that water will not be lost from the tank when connection or disconnection is made.

4-13.3.3.4 The tank fill connection(s) shall be sized to permit filling of the water tank in 2 minutes at a pressure of 80 psi (5.5 bar) at the tank intake connection.

4-13.4 Proportioning Foam System.

4-13.4.1 Foam-Liquid Concentrate Tank.

4-13.4.1.1 The purchaser shall specify the percent concentrate foam system to be provided. The foam-liquid concentrate tank(s) shall have a working capacity sufficient for 2 tanks of water.

4-13.4.1.2 Foam-liquid concentrate tanks may be of either rigid or flexible type. The tank(s) shall be designed for compatability with the foam concentrate being used and resist all forms of deterioration which could be caused by the foam concentrate or water.

4-13.4.1.3 Tanks shall be designed to provide ready access for internal and external inspection and service. A large capacity drain connection shall be installed flush with the bottom of the sump.

4-13.4.1.4 The tank outlets shall be located above the bottom of the sump and shall provide continuous foam-liquid concentrate to the foam proportioning system, with that system operating as specified in 4-13.4.3 and with the vehicle discharging 2 tank loads of usable water as specified in 4-13.3.1.

4-13.4.1.5 If separate from the water tank, the foam-liquid tank shall be mounted in a manner that limits the transfer of the torsional strains from the chassis frame to the tank, during off-pavement driving. The tank shall be separate and distinct from the crew compartment, engine compartment, and chassis and shall be easily removable as a unit.

4-13.4.1.5.1 A flexible tank shall be structurally supported to resist tearing. The structural support shall not be dependent on the fluid level in either the water or foam tanks.

4-13.4.1.6 A top fill trough shall be provided equipped with a stainless steel no. 10 mesh screen and container openers to permit emptying 5 gal (20 L) foam-liquid concentrate containers into the storage tank(s) at a rapid rate regardless of water tank level. The trough shall be connected to the foam-liquid storage tank(s) with a fill line designed to introduce foam-liquid concentrate near the bottom of the tank(s) so as to minimize foaming within the storage tank.

4-13.4.1.7 Tank fill connection(s) shall be provided in a position where they can be easily reached from the ground to permit the pumping of foam-liquid concentrate into the storage tank(s). The connection(s) shall be provided with strainers of 1/4-in. (6-mm) mesh and shall have check valves or be so constructed that foam will not be lost from the tank when connection or disconnection is made.

4-13.4.1.7.1 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 shall be capable of delivering foam-liquid at a rate at least equal to or greater than the maximum discharge rate of the foam system.

4-13.4.1.8 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. The vent outlets shall be directed to the ground to prevent spillage of foam-liquid concentrate on vehicle components.

4-13.4.2 Foam-Liquid Concentrate Piping.

4-13.4.2.1* The foam-liquid concentrate piping shall be of material resistant to corrosion by foam-liquid concentrate. Care shall be taken 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.

4-13.4.2.2 The foam-liquid concentrate piping shall be adequately sized to permit the maximum required flow rate and shall be arranged to prevent water from entering the foam tank.

4-13.4.3 Foam-Liquid Proportioning System.

4-13.4.3.1 The foam concentrate proportioning system shall provide a means of controlling the ratio of foam concentrate to the quantity of water in the foam solution being discharged from all orifices normally used for aircraft fire fighting operations.

4-13.4.3.2 The proportioning system shall be sufficiently accurate to provide for the discharge of finished foam within the range of 2.8 percent to 3.5 percent foam concentrate in the discharged foam/water solution for a 3 percent concentrate or 5.5 percent to 7.0 percent for a 6 percent concentrate.

4-13.5 Premixed — Pump System.

4-13.5.1 When premix solution in the main water tank is selected as the means of proportioning foam to water, the foam solution used shall be AFFF only. Care shall be exercised that the premixed solution is mixed to exact proportions. When premix is used, operation of the vehicle fire fighting system shall conform to the requirements of 4-13.2 and 4-13.3 of this standard.

4-13.6 Premixed — Pressurized System.

4-13.6.1 Liquid Agent Container(s).

4-13.6.1.1 The storage container(s) and liquid agent(s) shall be designed for pressurization and be constructed in accordance with the ASME, *Boiler and Pressure Vessel Code* and shall be so marked.

4-13.6.1.2 The material of construction shall be resistant to corrosion by the AFFF agent to be stored, or a suitable lining material shall be provided.

4-13.6.1.3 An ASME approved pressure relief valve of adequate capacity shall be provided on the container and set to prevent pressures in excess of the maximum design working pressure. A pressure gage shall be provided that will, at all times, indicate the internal pressure of the agent storage container.

4-13.6.1.4 A readily accessible fill opening of sufficient size to allow ease in filling, and stirring if necessary, shall be provided. It shall be in compliance with ASME or local codes and in no case less than 3 in. (76 mm) in diameter. The filling shall be accomplished without the removal of any of the extinguisher piping or any major component.

4-13.6.1.5 A means shall be provided to determine contents of the container as a guide in recharging partial loads.

4-13.6.2 Propellant Gas.

4-13.6.2.1 The propellant gas shall be dry nitrogen or dry compressed air and provided in sufficient quantity to expel the fire fighting agent as well as purge all piping and hose lines after use.

4-13.6.2.2 All propellant gas cylinders and valves shall be in accordance with the U.S. Department of Transportation (DOT) requirements or regulations. Cylinders shall bear the DOT marking.

4-13.6.2.3 The design of the propellant source shall provide for quick and easy replacement after each use.

4-13.6.2.4 A pressure gage shall be provided and shall at all times indicate the pressure of the propellant gas source.

4-13.6.2.5 Cylinder valves, gages, and piping shall be arranged as to preclude accidental mechanical injuries.

4-13.6.2.6 The cylinder valve shall be capable of being opened by quick-acting control and shall also be suitable for remote operation.

4-13.6.3 Pressure Regulation.

4-13.6.3.1 Pressure regulation shall be designed to reduce the normal cylinder pressure automatically and hold the propellant gas pressure at the designed operating pressure of the liquid agent container(s).

4-13.6.3.2 All pressure regulating devices shall be sealed or pinned at the designed operating pressures after final adjustment by the system manufacturer.

4-13.6.3.3 Pressure regulating devices shall be equipped with a spring-loaded relief valve that will relieve any excess pressure that may develop in the regulator.

4-13.6.3.4 The pressure regulator may be of a type without pressure indicating gages.

4-13.6.4 Piping and Valves.

4-13.6.4.1 All propellant 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 provide the designed flow of gas into the system and the minimum amount of restriction from the liquid agent container(s) to the hose connection. When more than 1 hose line is provided, piping and fittings shall be sized and designed so that there shall be equal flow to each line regardless of the number of lines placed in operation.

4-13.6.4.2 Provisions shall be made for the purging of all piping and hose of the liquid after use without discharging the liquid agent remaining in the container(s). Provisions shall also be made for the depressurization of the liquid agent container without the loss of the remainder of the liquid agent.

4-13.6.4.3 Drains shall be provided to permit complete draining of the system.

4-13.6.4.4 All valves shall be of the quarter-turn, quick-opening, ball type except on the gas cylinder covered in 4-13.6.2.2. A maximum of 2 operations, exclusive of the nozzle, shall be required to charge the system. Controls shall be arranged for simultaneous charging of the liquid agent and dry chemical systems.

4-13.6.4.5 A quick-acting control for operation by the driver to pressurize the liquid agent system from the cab of the vehicle shall be provided with similar control at the unit.

4-13.6.4.6 All valves and piping shall be resistant to corrosion by the foam-liquid concentrate.

4-13.6.4.7 A check valve shall be provided in gas piping to prevent the liquid agent from being forced back into the propellant gas line.

4-13.7 Dry Chemical System.

4-13.7.1 General.

4-13.7.1.1 The dry chemical container shall be constructed in accordance with the ASME *Code for Unfired Pressure Vessels* and shall be so stamped.

4-13.7.1.2 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 container to the hose connection. When more than 1 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.

4-13.7.1.3 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 container. Provisions shall also be made for the depressurization of the dry chemical container without the loss of the

remainder of the dry chemical. A pressure gage shall be provided that will, at all times, indicate the internal pressure of the agent storage container.

4-13.7.1.4 The system shall be designed to ensure fluidization of the dry chemical at the time of operation. Where any design includes the movement of the chemical container to fluidize the contents, such design shall also include a manual operating feature.

4-13.7.1.5 A check valve shall be provided in the gas piping to prevent the extinguishing agent from being forced back into the propellant gas line.

4-13.7.1.6 A means of pressure relief conforming to appropriate ASME Codes shall be provided for the dry chemical container 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.

4-13.7.1.7 The fill opening in the dry chemical container 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.

4-13.7.1.8 A quick-acting control for operation by the driver to pressurize the dry chemical agent system from the cab of the vehicle shall be provided with similar control at the hand line.

4-13.7.2 Propellants.

4-13.7.2.1 The propelling agent shall be dry nitrogen or dry air.

4-13.7.2.2 All propellant gas cylinders and valves shall be in accordance with the U.S. Department of Transportion (DOT) requirements or regulations. Cylinders shall bear the DOT marking.

4-13.7.2.3 The method of adequately pressurizing and propelling the dry chemical in the system shall provide a sufficient quantity of gas to expel the agent, as well as permitting the complete purging of all piping and hose lines after each use.

4-13.7.2.4 The design of the propellant source shall provide for quick and easy replacement after each use.

4-13.7.2.5 A pressure gage shall be provided and shall, at all times, indicate the pressure on the propellant gas source.

4-13.7.2.6 Cylinder valves, gages, and piping shall be arranged as to preclude accidental mechanical damage.

4-13.7.3 Pressure Regulation.

4-13.7.3.1 Pressure regulation shall be designed so that it will automatically reduce the normal cylinder pressure and hold the propellant gas pressure at the designed operating pressure of the dry chemical container.

4-13.7.3.2 All pressure regulating devices shall be sealed or pinned at the designed operating pressures after final adjustment by the system manufacturer.

4-13.7.3.3 Pressure regulating devices shall be equipped with a spring-loaded relief valve that will relieve any excess pressure that may develop in the regulator.

4-13.7.3.4 The pressure regulator may be of a type without pressure indicating gages.

4-13.8 Halon 1211 System.

4-13.8.1. Halon Container

4-13.8.1.1 The storage container shall be designed for pressurization and shall be constructed in accordance with the ASME *Boiler and Pressure Vessel Code* and shall be so marked.

4-13.8.1.2 The material of construction shall be resistant to corrosion by the Halon agent to be stored.

4-13.8.1.3 A readily accessible charge coupling of sufficient size to allow ease in filling shall be provided. The filling shall be accomplished without the removal of any of the extinguisher piping or any major component. A pressure gage shall be provided that will, at all times, indicate the internal pressure of the agent storage container.

4-13.8.1.4 A means shall be provided to determine contents of the container as a guide in recharging partial loads and to prevent overfilling of the tank.

4-13.8.2 Propellant Gas.

4-13.8.2.1 The propellant gas shall be dry nitrogen or dry compressed air and provided in sufficient quantity to expel the Halon agent as well as purge all piping and hose lines after use.

4-13.8.2.2 All propellant gas cylinders and valves shall be in accordance with the U.S. Department of Transportation (DOT) requirements or regulations. Cylinders shall bear the DOT marking.

4-13.8.2.3 Connecting pipes and valves to the Halon container shall conform to the appropriate ASME Code and designed to withstand the working pressure of the system.

4-13.8.2.4 The design of the propellant source shall be such that it will provide a quick and easy replacement after each use.

4-13.8.2.5 A pressure gage shall be provided which will at all times indicate the pressure on the propellant gas source.

4-13.8.2.6 Cylinder valves, gages, and piping shall be arranged as to preclude accidental mechanical injuries.

4-13.8.2.7 A check valve shall be provided in gas piping to prevent the liquid agent from being forced back into the propellant gas line.

4-13.8.3 Pressure Regulation.

4-13.8.3.1 An ASME approved pressure relief valve of adequate capacity shall be provided on the container and shall be set to prevent pressures in excess of the maximum design working pressure.

4-13.8.3.2 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 Halon container(s).

4-13.8.3.3 All pressure regulating devices shall be sealed or pinned at the designed operating pressures after final adjustment by the system manufacturer.

4-13.8.3.4 Pressure regulating devices shall be equipped with a spring-loaded relief valve that will relieve any excess pressure that may develop in the regulator.

4-13.8.3.5 The pressure regulator may be of a type without pressure indicating gages.

4-13.8.4 Halon Delivery Piping and Valves.

4-13.8.4.1 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 galvanic action. Piping shall be securely mounted and provided with flexible couplings to minimize stress.

4-13.8.4.2 All valves shall be quarter-turn type and selected for ease of operating and freedom from leakage.

4-13.8.4.3 All discharge piping shall be tested at 50 percent above system operating pressure.

4-13.8.4.4 When more than 1 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.

4-13.8.4.5 Provisions shall be made for the purging of all piping and hose of the Halon after use without discharging the Halon remaining in the container(s). Provisions shall also be made for venting of the Halon container without loss of the remainder of the liquid agent.

4-13.8.4.6 A quick-acting control for operation by the driver to pressurize the Halon system from the cab of the vehicle shall be provided with similar control at the hand line.

4-13.9 Turret Nozzles.

4-13.9.1 Class 1 vehicles shall not have a turret. Class 2 and 3 vehicles shall have a foam turret or a foam barrel and a dry chemical barrel in a twinned turret for simultaneous agent discharge.

4-13.9.2 The nominal foam solution discharge rate from the foam turret shall be 150 gpm (600 L/min) for Class 2 vehicles, and 250 gpm (1000 L/min) for Class 3 vehicles. The roof turret discharge rate shall have a tolerance of −0% or +10%.

4-13.9.3 Both single foam turrets and the foam barrel of a twinned turret for simultaneous agent discharge shall be capable of discharging foam as specified in Table 4-13.9.3, in still air in a variable pattern with the turret elevated to the maximum stream reach position.

Table 4-13.9.3 Foam Turret Barrel Pattern

Vehicle Class	Straight Stream	Dispersed Stream	
	Far Point Not Less than ft (m)	Full Width Not Less than ft (m)	Full Width Far point Not Less than ft (m)
2	125 ft (38 m)	20 ft (6 m)	25 ft (7.6 m)
3	125 ft (38 m)	25 ft (7.6 m)	25 ft (7.6 m)

4-13.9.4 The dry chemical barrel of a twinned turret for simultaneous agent discharge shall be designed to dispense the dry chemical agent at a minimum discharge rate of 16 lb (7 kg) per sec and with a minimum far point range of not less than 100 ft (30 m) with a pattern width not less than 17 ft (5 m) with turret stationary.

4-13.9.5 The foam barrel of a twinned turret for simultaneous agent discharge shall be positioned so that the foam stream pattern falls to the ground 10 ft (3 m) behind the dry chemical stream pattern.

4-13.9.6 Manual turret controls for both foam and dry chemical turrets shall be accessible both to the driver and crew member. Duplicate controls may be provided on cab roof. When the turret controls are provided with pneumatic or hydraulic power assist, an override control shall be provided to permit direct manual operation of the turret.

4-13.9.7 Both single and twinned turrets shall be capable of being elevated at least 45° above the horizontal and depressed to discharge agent within 20 ft (6 m) in front of the vehicle at full output using dispersed stream. The turret shall be capable of being rotated not less than 90° to either side, total traverse not less than 180°. Where 2 turrets are used on a vehicle, suitable stops shall be provided so that neither turret can interfere with the other turret.

4-13.9.8 Turrets shall be designed so that each agent may be discharged separately or simultaneously. The barrels shall be linked together to provide coordinated application by 1 operator.

4-13.10 Hand Lines, Reels, and Nozzles.

4-13.10.1 Combined agent vehicles shall have at least 1 primary hand line and nozzle for each agent. Hand lines and nozzles may be separate or twinned together for simultaneous agent discharge. Hand lines may be reeled hand lines specified in 4-13.10.2 or woven jacket hose lines specified in 4-13.10.3.

4-13.10.2 Reeled Hand Lines.

4-13.10.2.1 Hand lines for reels shall have a minimum internal diameter of 1 inch (25 mm) shall have a minimum burst pressure rating at least 3 times greater than the nominal working pressure of the system, and shall be able to discharge the gpm (L/min) required in 4-3.10.2.3 without unreeling the hose.

4-13.10.2.2 At least 100 ft (30 m) of hose shall be provided for each reel.

4-13.10.2.3 Each hand line shall be equipped with a shutoff type nozzle designed to discharge both foam and water at a nominal discharge rate of 60 gpm (240 L/min) ±5%. Each nozzle shall have minimum foam discharge patterns from a dispersed stream of 15 ft (4.5 m) width and 20 ft (6 m) range to a straight foam stream with a 50 ft (15 m) range.

4-13.10.2.4 Each reel shall have capacity for at least 100 ft (30 m) of 1-in. (25-mm) hose or more if specified by the purchaser.

4-13.10.2.5 Each reel shall be designed and positioned to permit hose line removal by a single person from any position in a 120° horizontal sector. Each reel shall be equipped with a friction brake to prevent hose from unreeling when not desired. Power rewind with manual override shall be provided. The nozzle holder, friction brake, rewind controls, and manual valve control shall be accessible from the ground.

4-13.10.2.6 Flow to each reel shall be controlled by a manually operated quarter-turn ball-type valve.

4-13.10.3 Woven Jacket Hand Lines.

4-13.10.3.1 Woven jacket hose lines shall have a minimum diameter of 1½ in. (38 mm) and shall meet the requirements of NFPA 1961, *Standard for Fire Hose.*

4-13.10.3.2 At least 150 ft (45 m) of hose shall be provided each hand line.

4-13.10.3.3 Each hand line shall be equipped with a shutoff type nozzle designed to discharge both foam and water at a nominal discharge rate of 95 gpm (380 L/min) ±5%. Each nozzle shall have minimum foam discharge patterns from a dispersed stream of 15 ft (4.5 m) width and 20 ft (6 m) range to a straight foam stream with a 65 ft (19.8 m) range.

4-13.10.3.4 Each hand line shall be stored, flat loaded, in a hose compartment and shall be preconnected. Each hose compartment shall have a capacity for a minimum of 150 ft (45 m) of 1½-in. (38-mm) multiple jacket hose or more if specified by the purchaser.

4-13.10.3.5 Hose compartments shall be fabricated from noncorrosive material and shall be designed to drain effectively. The compartment shall be smooth and free from all projections that might damage hose. No other equipment shall be mounted or located where it will obstruct the removal of the hose. The hose compartment shall not be more than 5½ ft (1.6 m) above the ground.

4-13.10.3.6 Flow to each hand line shall be controlled by a manually operated quarter-turn ball-type valve, located adjacent to the hand line.

4-13.10.4 Auxiliary Agent Hand Lines.

4-13.10.4.1 Hand lines for auxiliary agents shall have a minimum burst pressure rating of at least 3 times greater than the nominal working pressure of the system and shall meet the requirements of paragraphs 4-13.10.2 or 3-13.10.3. The auxiliary agent hand line shall be equipped with a nozzle that allows full open to closed position in 1 simple movement and shall be designed to discharge agent at a minimum rate of 5 lb (2.2 kg) per second at a minimum range of 20 ft (6 m). Nozzle construction shall be of nonferrous metal or stainless steel.

4-13.10.4.2 Twinned hand lines and nozzles shall be designed so that each agent may be discharged separately or simultaneously. The barrels shall be linked together to provide coordinated application by 1 operator.

4-13.11 Foam Quality.

4-13.11.1 Turrets and hand lines shall discharge foam having the quality specified in Table 4-13.11.1.

Measurement of expansion ratio and 25 percent drainage times shall be in accordance with the procedures outlined in NFPA 412, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles.*

4-14 Lighting and Electrical Equipment.

4-14.1 Lighting equipment shall be installed in conformity with local road regulations when practicable and shall include the following:

(a) Headlights with upper and lower driving beams. A control switch that is readily accessible to the driver shall be provided for beam selection.

(b) Dual taillights and stoplights.

(c) Turn signals, front and rear, with a steering column mounted control and a visual and audible indicator. A 4-way flasher switch shall be provided.

(d) 6-in. (152-mm) minimum spotlight on both left and right sides of the windshield, hand adjustable type, with controls for beam adjustments inside the truck cab.

(e) Adequate reflectors, and marker and clearance light, shall be furnished to describe the overall length and width of the vehicle.

(f) Engine compartment lights, nonglare type, arranged to illuminate both sides of the engine with individual switches located in the engine compartment.

Table 4-13.11.1 Foam Quality

	Protein and Fluoroprotein Air-aspirating Nozzles		Foam-Liquid Type AFFF Air-aspirating Nozzles		AFFF Nonair-aspirating Nozzles	
	Expansion Ratio	Minimum 25 percent Drainage, in Minutes	Minimum Expansion Ratio	Minimum 25 percent Drainage, in Minutes	Minimum Expansion Ratio	Minimum 25 percent Drainage, in Minutes
Turrets	8 to 12	5	5	4	3	1
Hand Lines	8 to 12	5	5	4	3	1

(g) Two swivel mounted lights, 6-in. (152-mm) minimum with clear lens and individual switches, to be mounted on the top deck for equipment lighting.

(h) At least 1 back-up light and an audible alarm installed in the rear of the body.

(i) 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.

4-14.2* A warning system shall be provided having a sound output of not less than 95 decibels at 100 ft (30 m) directly ahead of the siren and not less than 90 decibels at 100 ft (30 m) measured at 45° 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.

4-14.3 An electric or air horn shall be provided and shall be mounted at the front part of the vehicle with the control positioned such that it is readily accessible to the driver.

4-14.4 Radios.

4-14.4.1 Provision shall be made for mounting radios. Operation of the radios shall be from the cab. Radios shall be mounted permitting quick servicing or replacement.

4-14.4.2 Purchaser shall specify radios that will ensure that all required radios and frequencies are provided for.

4-15 Tools.

4-15.1* Provision shall be made for mounting on the truck, tools, and equipment specified by the purchaser. Special tools as required for servicing the vehicle, servicing the fire suppression system, and servicing the auxiliary equipment shall be furnished by the vehicle manufacturer.

Chapter 5 Acceptance Criteria

5-1 General.

5-1.1 Compliance with the requirements of this standard shall be verified by one of the following methods:

(a) Component manufacturer's certification.

(b) Prototype vehicle tests.

(c) Operational tests.

5-1.2 Component manufacturer's certification shall be provided where specified in Section 5-2. The manufacturer shall certify that the component is approved for use in the RFF application.

5-1.3 Prototype vehicle tests shall be conducted by the manufacturer in accordance with the standardized procedures found in Section 5-3 to ensure that the performance requirements were achieved with the design. Calculated performance capability shall not be substituted for an actual prototype test.

5-1.4 Operational tests shall be either at the airport or the manufacturer's facility as specified in Section 5-4. The test shall be conducted by the manufacturer on every vehicle built.

5-1.5 The manufacturer of the vehicle shall demonstrate to the purchasing authority or their designee the care and maintenance and operational capability of the vehicle.

5-2 Component Manufacturer's Certification.

5-2.1 A copy of the manufacturer's signed application approval shall be provided with the vehicle documents for the following components:

(a) Engine
(b) Transmission
(c) Axles
(d) Transfer case
(e) Wheels
(f) Tires
(g) Hand line hose with couplings attached
(h) Premixed storage container
(i) Premixed system pressure relief valve
(j) Propellant gas cylinder
(k) Propellant gas cylinder regulating device
(l) Complementary agent storage container
(m) Complementary agent pressure relief device.

5-2.2 The cooling system shall be certified by the vehicle manufacturer to satisfy all operational conditions at all ambient temperatures encountered at the operational airport for both the engine and transmission.

5-2.3 The brake system shall be certified by the vehicle manufacturer to satisfy the service brake, emergency brake, and grade holding performance requirements for the corresponding class of vehicle.

5-2.4 When the vehicle is equipped with an air brake system, the vehicle manufacturer shall provide itemized, certified data relative to the air system as follows:

(a) Total reservoir capacity

(b) Total required volume (12 times the total combined brake chamber volume at full stoke)

(c) Quick buildup system capacity

(d) Quick buildup system pressure required to release the spring brakes.

5-3 Prototype Vehicle Tests.

5-3.1 Rated Water/Foam Tank Capacity Test.

5-3.1.1 Test facilities shall consist of an open site suitable for discharging agent that includes both level ground and measured grades of at least 20% and 30%. Access to a refill water supply is required.

5-3.1.2 Test equipment shall consist of the following:

(a) A calibrated sight gage

(b) Liquid volume measuring device accurate to within ± 1.0%.

5-3.1.3 The vehicle shall have had its primary turret(s) discharge rate verified prior to beginning this test to ensure that the turret(s) will discharge at or above the minimum rate specified, and the accuracy of the foam metering system shall have been verified.

5-3.1.4 The rated water and foam tank capacity shall be determined as follows:

(a) Park the vehicle on level ground.

(b) Attach a calibrated site gage to both the water tank and the foam tank.

(c) Fill the water piping up to a level even with the bottom of the tank. Do not record the water quantity used.

(d) While filling both tanks with a liquid volume measuring device, the amount of water added to each tank shall be correlated with the site gage calibrations and recorded. When the tanks are filled to the top, the total liquid capacity shall also be recorded for each tank respectively.

(e) Add dye to the foam tank.

(f) The agent system shall be set to discharge at the specified foam solution rate, and the system discharge pressure shall be adjusted to the recommended pressure.

(g) Starting with completely filled tanks, discharge at maximum rate through the primary turret(s) until the agent pump(s) show a drop in discharge pressure, and then stop immediately. Dye shall be apparent in the discharge stream throughout the test.

(h) Measure the amount of liquid remaining in both tanks and convert to gallons using the conversion established in step (d). Subtract the amount remaining from the total capacity to determine the amount pumped out. The total amount of liquid pumped out of the tanks shall be recorded.

(i) The water tank shall be refilled but not the foam tank. Discharge this second tank as in step (g). Dye shall again be apparent throughout the test. Measure and record the additional amount of liquid discharged from the foam tank. The water tank shall be filled and discharged as many times as necessary to eliminate all useable liquid from the foam tank.

(j) The amount of liquid discharged from the foam tank from the time of initial fill shall be totaled and recorded.

(k) Refill both tanks and repeat steps (e) through (i) with the vehicle parked in the following attitudes.

Note: After pumping on a slope the vehicle must be returned to level ground to measure the water volume discharged.

1. 20% side slope, left side up
2. 20% side slope, right side up
3. 30% slope, ascending
4. 30% slope, descending

(l) The volume of liquid discharged from each tank on the 4 slope conditions shall be divided by .75 and recorded.

5-3.1.5 The rated or useable water tank capacity shall be the lesser of the volumes calculated in 5-3.1.4(h) or 5-3.1.4(l). The rated or useable foam tank capacity shall be the lessor of the volumes calculated in 5-3.1.4(j) or 5-3.1.4(l).

5-3.2 Side Slope.

5-3.2.1 Test facilities shall consist of either a measured fixed grade equal to or in excess of the slope requirement for the class of vehicle being tested or a surface on which the tires of the vehicle can be placed that is capable of being tilted. Means to restrain the vehicle at the balance point are required.

5-3.2.2 Test equipment shall consist of a suitable inclinometer capable of measuring the slope of the support surface with an accuracy of ± 1 degree.

5-3.2.3 The vehicle shall be tested in its "fully loaded condition" (*see definition*) with tires inflated to their recommended operating pressure. Suitable ballast shall be used in place of the crew for safety considerations.

5-3.2.4 The side slope capability of the vehicle shall be determined as follows:

(a) Tilt the vehicle on a table or position the vehicle on a grade having an angle above the horizon at least equal to the side slope angle specified for the vehicle being tested.

(b) Once the vehicle is positioned at the required angle, check the vehicle restraints to ensure that no tension is applied.

5-3.2.5 The vehicle shall be considered to meet its side slope requirement if the vehicle can stand by itself on the grade without being assisted by the safety restraints.

5-3.3 Cornering Stability.

5-3.3.1 The test facility shall consist of a level site having a dry, paved surface at least 250 ft (75 m) in diameter, free from loose material upon which a 100 ft (30 m) radius circle shall be marked in a manner that can easily be followed by a driver.

5-3.3.2 A calibrated speedometer and a means of indicating steering wheel angle are required.

5-3.3.3 The vehicle shall be tested in its "fully loaded condition" (*see definition*).

5-3.3.4 The vehicle shall be tested as follows:

(a) The vehicle shall be driven slowly around the 100 ft (30 m) radius circle while keeping the centerline of the front of the vehicle directly over the marked line.

(b) A reference position on the steering wheel position indicator shall be established at a slow speed.

(c) The speed shall be increased gradually until the maximum safe speed, as judged by the driver, is reached.

(d) The maximum speed and the corresponding position of the steering wheel shall be recorded.

(e) Steps (a) through (d) shall be repeated while driving the vehicle in the opposite direction.

5-3.3.5 The speed achieved shall equal or exceed the requirement for the corresponding class of vehicle, and the steering angle shall not decrease with increasing speed.

5-3.4 Vehicle Dimensions.

5-3.4.1 Test facilities shall consist of a flat measurement pad that is large enough to position the complete vehicle on.

5-3.4.2 Test equipment shall consist of a tape measure and a protractor.

5-3.4.3 The vehicle shall be tested in its "fully loaded condition" (*see definition*) with tires inflated to their recommended operating pressure.

5-3.4.4 The following vehicle dimensions shall be measured in accordance with their definitions with the vehicle positioned on the flat pad:

(a) angle of approach

(b) angle of departure

(c) interaxle clearance angle

(d) under-body clearance

(e) under-axle clearance.

5-3.4.5 Linear dimensions shall be rounded down to the nearest 1/2 in. and angular dimensions shall be rounded down to the nearest 1/2 degree and compared against the vehicle specifications.

5-3.5 Driver Visibility Measurement.

5-3.5.1 The test facilities shall consist of a level site at least 20 ft (6.1 m) longer than the vehicle.

5-3.5.2 The test equipment shall consist of a plumb bob, tape measure, and a protractor or an inclinometer.

5-3.5.3 The vehicle shall be tested in its "fully loaded condition" (*see definition*) with tires inflated to their recommended operating pressure.

5-3.5.4 The driver's visibility shall be determined as follows:

(a) Adjust the driver's seat to its mid position with respect to height, weight, and fore and aft adjustments.

(b) Place a suitable structure on the seat cushion for locating an eye height of 31 3/4 in. (805 mm) and a position 12 in. (30.5 cm) forward from the seat back. The seat back shall be in a vertical position.

(c) Establish the features that limit the upward and downward line of sight directly in front of the driver's seat.

(d) Measure and record the angle above the horizon at which the upward vision is obstructed from the eye point established in step (b).

(e) Establish the lowest possible line of sight below the horizon directly in front of the eye point and project this line forward of the cab until you intersect the ground. This line of sight may be projected by use of a light beam, or if the windshield is removed a stringline can be used. Measure and record the distance from this intersection with the ground and the front face of the bumper at the front of the truck.

(f) By stretching a line from the eye point laterally across the cab, establish and record the 90 degree line of sight to the left and right of the straight ahead position. Obstructions within these angles shall be noted.

5-3.5.5 The recorded values for the distance at which the line of sight meets the ground in front of the truck and the angle of sight above the horizon shall equal or exceed the vehicle's specification. Obstacles within the 90° horizontal line of sight to the right or left shall not create an obstruction of more than 5° per obstruction.

5-3.6 Pump and Roll on 40 Percent Grade.

5-3.6.1 Test facilities shall consist of a site suitable for discharging agent that includes a measured grade of 40 percent at least twice the vehicle's length or a level paved test pad adequate for an extended draw bar pull.

5-3.6.2 Test equipment shall consist of the following:

(a) Calibrated speedometer

(b) Vehicle equipped pump pressure gage

(c) Load cell accurate to within ± 500 lb (applicable only to the alternate draw bar method)

(d) Variable load dynamometer sled (applicable only to the alternate draw bar method).

5-3.6.3 The vehicle shall have had its primary turret(s) discharge rate and pressure verified prior to beginning this test to ensure that the turret(s) will discharge at or above the minimum rate specified. The vehicle shall be tested in its "fully loaded condition" (*see definition*) with tires inflated to their recommended operating pressure.

5-3.6.4 The capability of the vehicle to ascend, stop, start, and continue ascent on a 40 percent grade without interruption in the discharge rate shall be demonstrated either on an actual grade or by means of an equivalent draw bar test as follows:

(a) Both the water and foam tanks shall be filled with water and dye added to the foam tank.

(b) The agent system shall be set to discharge in the foam mode, and the system discharge pressure should be set for optimum performance.

(c) The vehicle shall be positioned at the bottom of a 40 percent grade and discharge initiated at full output through the primary turret nozzles. Dye must be apparent in the discharge stream throughout the test.

(d) The vehicle shall initiate its ascent of the grade and achieve a speed of at least 1 mph (1.6 km/hr). During the ascent, the vehicle shall be able to be brought to a stop and resume its ascent at a speed of at least 1 mph (1.6 km/hr) without interruption in the discharge stream. The vehicle speed and any variation in discharge pressure shall be recorded.

(e) If an actual 40 percent grade is not available, then the above shall be repeated with the vehicle coupled to a 40 percent grade equivalent draw bar load to be determined as follows:

40 percent grade - 21.8° angle

Loaded vehicle weight × Sin 21.8° (.371) equals required draw bar pull to simulate ascending a 40 percent grade.

Area of the load cell must be determined at the time of the test.

The load cell reading in psi that will simulate a 40 percent grade must equal:

$$\frac{\text{Sin } 21.8° \times \text{Vehicle Weight}}{\text{Area of Load Cell}}$$

5-3.6.5 The vehicle shall negotiate the grade or draw bar pull smoothly while maintaining an operating pressure of at least 50 percent of the specified design pressure for the primary turret(s) at speeds of at least 1 mph (1.6 km/hr).

5-3.7 Electrical Charging System.

5-3.7.1 Test facilities shall consist of an area suitable for running the engine while the electric loads and charging rates are being measured.

5-3.7.2 Test instrumentation shall consist of the following:

(a) A laboratory quality voltmeter with a scale range compatible with the design voltage of the vehicle's electrical system. The scale on the voltmeter shall be graduated to allow reading voltages with a ±.1 volt accuracy.

(b) A laboratory quality ammeter with a scale range compatible with the anticipated electrical load present on the vehicle. The ammeter shall be graduated to allow reading current flow within a ± 3 percent accuracy.

(c) The vehicle installed tachometer.

5-3.7.3 The test vehicle shall have a fully charged set of batteries, and the vehicle's electric and charging systems shall be fully operational. The test shall be conducted in ambient conditions between 50° and 90°F (10° and 32°).

5-3.7.4 The test shall be conducted as follows:

(a) Each battery cell shall be checked to verify that voltage and specific gravity are at the battery manufacturer's specifications.

(b) A voltmeter shall be installed to continuously monitor the battery charge throughout the test.

(c) An ammeter/shunt system shall be installed at the battery to measure the full current demand of the electrical system. Another ammeter/shunt system shall be installed at the alternator to measure the total current output of the alternator.

(d) Voltages and amp readings shall be taken under the following conditions:

1. Battery alone.

2. Engine at idle and all electrical devices shut off. The engine shall be allowed to run long enough after starting to recharge the batteries prior to making these measurements.

3. Engine at idle and all electrical loads normally running simultaneously shall be turned on.

4. Engine at 50 percent governed speed with all electrical loads normally running simultaneously turned on.

5. Engine at governed speed with all electrical loads normally running simultaneously turned on.

5-3.7.5 The electrical system performance shall be compared against the specification at engine idle and at 50 percent engine rpm. The measured voltage of the batteries shall remain above 13 V (for a 12 V system) and 26 V (for a 24 V system) at all times while the alternator is running.

5-3.8 Radio Suppression.

5-3.8.1 Test facilities shall be specified in SAE J551 or the equivalent standard being used.

5-3.8.2 Test equipment shall be specified in SAE J551 or the equivalent standard being used.

5-3.8.3 The vehicle shall be configured with all standard electrical features mounted and operational. During the tests all vehicle engines shall be operated at idle, and all vehicle mounted electrical devices normally functioning at the crash site shall be turned on with the following stipulations:

(a) All vehicle lighting shall be on.

(b) All heating, defrosting, and air conditioning systems shall be on with their respective fans adjusted to the maximum speed setting.

(c) Auxiliary power generating devices (where applicable) shall be running.

(d) Intermittent warning devices, such as hazard flashers, warning buzzers, and horns, shall be turned off.

5-3.8.4 The vehicle shall be tested in accordance with SAE J551 or the equivalent standard being used.

5-3.8.5 The results of the test shall be evaluated in accordance with SAE J551 or the equivalent standard being used.

5-3.9 Gradability Test.

5-3.9.1 Test facilities shall consist of a site that includes a measured grade of 50 percent at least equal to the vehicle in length or a level paved test pad adequate for an extended draw bar pull.

5-3.9.2 Test equipent shall consist of the following:

(a) Load cell accurate to within ± 500 lb (applicable only to the alternate draw bar method).

(b) Variable load dynamometer sled (applicable only to the alternate draw bar method).

5-3.9.3 The vehicle shall be tested in its "fully loaded condition" (*see definition*) with tires inflated to their recommended operating pressure.

5-3.9.4 The capablity of the "fully loaded vehicle" (*see definition*) to ascend a 50 percent grade shall be demonstrated either on an actual grade or by means of an equivalent draw bar pull test. If an actual 50 percent grade is not available, then the vehicle shall be coupled to a 50 percent equivalent draw bar load to be determined as follows:

50 percent grade - 26.57° angle

Loaded vehicle weight × Sin 26.57° (.447) equals required draw bar pull to simulate ascending a 50 percent grade.

Area of the load cell must be determined at the time of the test.

The load cell reading in psi that will simulate a 50 percent grade must equal:

$$\frac{\text{Sin } 26.57^\circ \times \text{Vehicle Weight}}{\text{Area of Load Cell}}$$

5-3.9.5 The vehicle shall negotiate the grade or draw pull smoothly and safely.

5-3.10 Body and Chassis Flexibility Test.

5-3.10.1 Test facilities shall consist of a flat test pad suitable for discharging agent and securing portable ramps under the vehicle.

5-3.10.2 Test equipment shall consist of two to four 14 in. (35.6 cm) ramps with flat tops large enough for the tire foot print and graduated on both sides to allow the vehicle to ascend and descend safely.

5-3.10.3 The vehicle shall be tested in its "fully loaded condition" (*see definition*) with tires inflated to their recommended operating pressure.

5-3.10.4 The vehicle shall be tested as follows:

(a) For a 4 × 4, drive the fully loaded vehicle onto 14 in. (35.6 cm) blocks positioned under the diagonally opposite front and rear wheels. For a 6 × 6 this would involve axle number 1 and axle number 3. For an 8 × 8 this would involve axle number 1 and axle number 4.

(b) With the vehicle in this position:

1. The vehicle shall be thoroughly inspected to ensure that there are no sheetmetal interferences and that all moving parts are free to function.

2. All systems shall be demonstrated to function normally including discharge from all orifices.

(c) For a 6 × 6 and 8 × 8 add a block under the second wheel of the bogie axle(s) so that both wheels on one side of the tandem axle are elevated simultaneously and diagonally opposite front and rear, and then repeat the subpart (b) inspection.

(d) Switch the blocks to the opposite sides of the truck and repeat steps (a) through (c).

5-3.10.5 No moving part shall interfere with another. If component contact should occur it shall in no way damage the component or detract from the vehicle's ability to carry out its mission. No clearance shall be allowed between any tire and its supporting surface.

5-3.11 Service/Emergency Brake Test.

5-3.11.1 The test facilities shall consist of any dry, smooth, level, paved surface adequate in length to reach the respective test speeds and stop safely. The test area shall be marked in a manner that a lane, the width of the vehicle plus 4 ft, can be established.

5-3.11.2 Instrumentation shall consist of the following:

(a) Calibrated fifth wheel type speed measuring device that is accurate to within ± 0.5 mph (.8 km/h) or ± 0.5 percent of the actual vehicle speed.

(b) A ground speed readout device controlled by the fifth wheel.

(c) A trigger device that detects brake pedal movement.

(d) A strip chart recorder suitable for recording distance traveled, vehicle speed, and the point at which actuation of the brake system occurs.

5-3.11.3 The vehicle shall be tested in its "fully loaded condition" (*see definition*) with the brakes adjusted and the tires inflated to the vehicle manufacturer's recommended specifications. The brakes shall have been adequately burnished to ensure repeatable results.

5-3.11.4 The service and emergency brake stopping distances shall be determined in the following manner:

(a) While traveling down the center of the lane established by the width of the vehicle plus 4 ft, attain a speed slightly above the desired test speed and release the throttle.

(b) With the strip chart recorder running, at the instant that the vehicle reaches the desired test speed, actuate the brake pedal as if in a panic stop and continue applying the brakes until the vehicle comes to a complete stop. The brake pedal may be modulated during the stop, as necessary, to maintain vehicle control. Record the distance traveled from the time that the brake pedal was applied to the time that the vehicle came to rest.

(c) Observe whether or not the vehicle left the established lane during the brake stop.

(d) Repeat steps (a) through (c) for a total of 5 stops from each test speed.

(e) Repeat steps (a) through (d) to obtain results at speeds of 20 mph (32 km/h) and 40 mph (64 km/h).

(f) Disable the front service brakes and repeat steps (a) through (d) from a test speed of 40 mph (64 km/h).

(g) Reconnect the front service brakes and disable the rear service brakes and repeat steps (a) through (d) from a test speed of 40 mph (64 km/h).

5-3.11.5 Each of the recorded stops shall be within the specified distance without any part of the vehicle leaving the established test lane.

5-3.12 Service/Parking Brake Grade Holding Test.

5-3.12.1 The test facilities shall consist of dry, smooth, measured grades of 20 percent and 50 percent that are at least equal to the vehicle in length.

5-3.12.2 No instrumentation is required.

5-3.12.3 The vehicle shall be tested in its "fully loaded condition" (*see definition*) with the brakes adjusted and the tires inflated to the vehicle manufacturer's recommended specifictions. The brakes shall have been adequately burnished to ensure repeatable results.

5-3.12.4 The tests shall be conducted in the following manner:

(a) Drive the vehicle in a forward direction onto the 20 percent grade, stop, and set the parking brake.

(b) Shift the transmission to neutral and release the service brakes and verify that there is no wheel rotation.

(c) Repeat steps (a) and (b) with the vehicle facing the opposite direction.

(d) Drive the vehicle in a forward direction onto the 50 percent grade, apply the service brakes, and shift the transmission to neutral.

(e) Verify that there is no wheel rotation.

(f) Repeat steps (d) and (e) with the vehicle facing the opposite direction.

5-3.12.5 The brakes must be able to lock the wheels and hold the vehicle stationary on both the 20 percent and 50 percent grades with the vehicle pointed either uphill or downhill.

5-3.13 Steering Control Test.

5-3.13.1 The test facilities shall consist of any dry, level, paved surface free from loose material.

5-3.13.2 Test equipment shall consist of a steering wheel torque meter or a spring scale.

5-3.13.3 The vehicle shall be tested in a "fully loaded condition" (*see definition*) with tires inflated to their normal operating pressure.

5-3.13.4 The vehicle shall be tested as follows:

(a) Set the road wheels in the straight ahead position, engage neutral, and release the brakes, ensuring that there is no vehicle movement.

(b) With the engine at idle speed, measure and record the force applied to the steering rim which is required to turn the steering linkage from stop to stop.

5-3.13.5 The measured force shall not exceed the design specifications.

5-3.14 Vehicle Clearance Circle Test.

5-3.14.1 The test facilities shall consist of a level site having a dry, paved surface greater than 3 times the vehicle's length in diameter and shall be free from loose material.

5-3.14.2 A tape measure, markers or marking device, and a calculator are required.

5-3.14.3 The vehicle's steering system must be fully operational, and the steering linkage stops must be adjusted within the manufacturer's specified production tolerance limits.

5-3.14.4 The vehicle shall be tested as follows:

(a) Drive the vehicle in a full cramp, left or right turn as required, in at least one complete circle to fully "settle" the wheels into their steady state condition.

(b) Slowly drive the vehicle in the full cramp turn.

(c) Stop the vehicle in 3 locations around the turning circle (brake application must be smooth and gradual).

(d) At each stop, mark the outermost projected point of the vehicle on the ground.

(e) Measure and record the straight line distances between each groups of marks (length 1, length 2, and length 3).

(f) Calculate the vehicle clearance circle radius (R) as follows:

$$S = \text{length 1} + \text{length 2} + \text{length 3}$$

$$R = \frac{(\text{length 1})(\text{length 2})(\text{length 3})}{4\,[S\,(S - \text{length 1})\,(S - \text{length 2})\,(S - \text{length 3})]^{1/2}}$$

(g) Repeat steps (a) through (f) with the vehicle turning in the opposite direction.

5-3.14.5 The vehicle's clearance circle diameter (2R) must be less than 3 times the maximum overall length of the vehicle.

5-3.15 Agent Pump(s)/Tank Vent Discharge Test.

5-3.15.1 Test facilities shall consist of a level open site suitable for discharging agent. Access to a refill water supply is required.

5-3.15.2 Test equipment shall consist of a liquid level measuring device accurate to with ± 1.0 percent.

5-3.15.3 The vehicle shall have had each discharge nozzle individually verified to be discharging at a flow rate at or above the minimum rate specified when the agent system is operated at the recommended pressure.

5-3.15.4 The test shall be conducted as follows:

(a) The water and the foam tank shall be filled to the top.

(b) The foam proportioning system shall be set to proportion foams at the concentration specified and the agent selector set for the foam mode.

(c) The agent system pressure relief shall be set to the recommended pressure.

(d) The agent pumps shall be engaged and brought up to maximum pumping speed with all discharge outlets closed.

(e) Discharge of the primary roof turret(s), primary hand lines, ground sweeps/bumper turret, and undertruck nozzles shall be initiated simultaneously. After approximately 75 percent of the contents from the water tank have been discharged, discharge through all nozzle outlets shall be stopped simultaneously. The time of discharge shall be recorded.

(f) The total amount of liquid discharged from the water and foam tanks shall be measured and added together. The average discharge rate shall be calculated using the discharge time from step (e).

(g) The quantity of liquid used from the foam tank shall be calculated as a percentage of the total liquid discharged.

5-3.15.5 The measured total discharge rate shall at least equal the sum of the minimum specified discharge rates of the nozzles used during the test. A calculated average foam concentration within the tolerance allowed for the respective foam type will confirm the adequacy of the foam-liquid concentrate piping to supply foam at a rate compatible with the maximum discharge requirements of the vehicle.

5-3.16 Water Tank Fill and Overflow Test.

5-3.16.1 The test facilities shall consist of a level site with pumping and/or hydrant capacity sufficient to provide the water delivery rate required to fill the water tank in 2 minutes at an inlet pressure of 80 psi.

5-3.16.2 Instrumentation shall consist of calibrated mechanical or electronic pressure measuring devices with an accuracy of ± 3 percent and a stopwatch.

5-3.16.3 The water tank shall be empty, and the water tank fill and vent system shall be fully operational for this test.

5-3.16.4 The adequacy of the water tank fill and vent system to permit the tank to be filled in 2 minutes or less shall be tested as follows:

(a) Park the vehicle on level ground.

(b) Attach 1 pressure measuring device at the inlet to tank fill piping, and attach the other pressure measuring device to the tank body or an extension of the tank body.

(c) Simultaneously initiate flow to the tank and start the stopwatch. The water supply pressure shall be maintained at 80 psi throughout the test.

(d) At the moment water begins to flow from the overflow piping, the watch shall be stopped and the elapsed time recorded.

(e) While maintaining an 80 psi supply pressure and an overflow condition, record the internal tank pressure. After recording this pressure, shut off the water supply.

5-3.16.5 The results of this test shall be evaluated as follows:

(a) The time to fill the tank to the overflow condition shall be 2 minutes or less.

(b) The internal tank pressure shall not exceed the tank design pressure.

5-3.17 Flushing System Test.

5-3.17.1 Test facilities shall consist of an open site suitable for discharging agent and draining the vehicle. Access to a refill water supply is required.

5-3.17.2 No special instrumentation is required for this test.

5-3.17.3 The vehicle's agent system and flushing system shall be fully operational for this test.

5-3.17.4 The vehicle's flushing system shall be tested as follows:

(a) Fill the water tank and foam tank with clean water and add dye to the foam tank.

(b) Discharge agent through each discharge orifice on the vehicle while operating in the foam mode until dye is present in the discharge stream.

(c) Mark the liquid level in the foam tank.

(d) Set the agent system in the flush mode and discharge through each discharge orifice until clear water is present in the discharge stream.

(e) Shut the agent system down and drain the piping.

(f) Recheck the foam tank level.

5-3.17.5 A failure to develop a clear water stream through each nozzle is evidence that the flushing system is inadequate. There shall be no evidence of feedback of clear water into the foam tank.

5-3.18 Roof Turret Flow Rate Test.

5-3.18.1 Test facilities shall consist of a level open site suitable for discharging agent. Access to a refill water supply is required.

5-3.18.2 Test equipment shall consist of the following:

(a) A calibrated sight gage.

(b) Liquid volume measuring device accurate to within ± 1 percent.

(c) A calibrated pressure gage if not already provided on the truck.

5-3.18.3 It shall have been verified that the vehicle's pumping system is capable of operating at full rate.

5-3.18.4 The roof turret discharge rate shall be determined as follows:

(a) The roof turret pattern shall be set for straight stream operation.

(b) The water tank shall be completely filled.

(c) Engage pump and bring up to design speed.

(d) Open turret flow control valve.

(e) 1. If flow meters are used, read and record the flow rate once the discharge pressure stabilizes.

2. If a sight gage is used, read and record the tank volume in gallons while simultaneously starting a stop watch after the discharge pressure stabilizes. Read and record the tank volume in gallons when the watch is stopped after allowing flow for at least 1 minute. Determine the flow rate in gpm by dividing the difference in gallons by the time of discharge.

(f) Reset the roof turret pattern to the dispersed setting and repeat steps (b) through (e).

(g) Reset the roof turret to the half flow rate setting (if applicable) and repeat steps (a) through (f).

5-3.18.5 The measured turret flow rates shall equal the specified flow rate within a tolerance of + 10 percent or − 0 percent.

5-3.19 Roof Turret Pattern Test. The roof turret pattern test shall be conducted in accordance with the requirements of NFPA 412, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles,* and the results evaluated in accordance with the vehicle specifications.

5-3.20 Roof Turret Control Force Measurement.

5-3.20.1 Test facilities shall consist of a level, open site suitable for discharging agent. Access to a refill water supply is required.

5-3.20.2 Test equipment shall consist of a spring scale that can be attached to the end of the turret control handle or a torque measuring device that can be attached to the rotational axis of the turret.

5-3.20.3 The water tank shall be filled prior to starting the test, and it shall have been verified that the vehicle pump system is capable of operating at design flow and pressure. The test shall be conducted with the roof turret at the full flow rate setting. The turret power assist system, if applicable, shall be fully operational.

5-3.20.4 The test shall be conducted as follows:

(a) Set the turret pattern control for straight stream and, where applicable, engage the power assist.

(b) Engage pump and bring up to designed speed.

(c) Open turret flow control valve.

(d) Using a spring scale attached to the end of the turret aiming handle, rotate the turret to the right and to the left recording the force required in each direction. Again, using the spring scale attached to the end of the turret aiming handle, elevate and depress the turret recording the force to elevate and depress.

(e) Repeat steps (b) through (d) with the pattern control set at the maximum dispersed position after refilling the water tank as necessary.

5-3.20.5 The forces recorded shall not exceed the forces specified.

5-3.21 Roof Turret Articulation Test.

5-3.21.1 The facilities shall consist of a level, open site suitable for discharging agent. Access to a refill water supply is required.

5-3.21.2 The test equipment shall consist of a tape measure, a level, and a protractor.

5-3.21.3 The water tank shall be filled prior to the test, and the turret power assist system, if applicable, shall be fully operational.

5-3.21.4 The test shall be conducted as follows:

(a) With the turret pointed ahead, raise the turret barrel to the maximum elevated position. With a level held horizontal at the vertical rotation axis, measure the angle between the level and the turret barrel with the protractor and record.

(b) Rotate the roof turret barrel to the right and left to the required angle.

(c) Place a marker 30 ft (9 m) in front of the vehicle. The turret shall be aimed straight ahead with rate control at full flow, with pattern control in the maximum dispersed position, and with the turret in the maximum depressed position. Water shall be discharged. It shall be observed if water strikes the marker or closer to the vehicle.

5-3.21.5 Turret articulation is acceptable if the measurements meet or exceed the specifications.

5-3.22 Hand line Nozzle Flow Rate Test.

5-3.22.1 Test facilities shall consist of an open site suitable for discharging agent. Access to a refill water supply is required.

5-3.22.2 Test equipment shall consist of the following:

(a) A calibrated sight gage.

(b) Liquid volume measuring device accurate to within ± 1 percent.

(c) A calibrated pressure gage if not already provided on the truck.

5-3.22.3 The vehicle shall have been verified that its pumping system is capable of operating at full rate.

5-3.22.4 The hand line nozzle flow rate shall be determined as follows:

(a) Set hand line nozzle pattern for straight stream operation.

(b) Fill water tank completely.

(c) Engage pump and bring up to design speed.

(d) Open hand line nozzle flow control valve.

(e) 1. If flow meters are used, read and record the flow rate once the discharge pressure stabilizes.

2. If a sight gage is used, read and record the tank volume in gallons while simultaneously starting a stop watch after the discharge pressure stabilizes. Read and record the tank volume in gallons when the watch is stopped after allowing flow for at least 1 minute. Determine the flow rate in gpm by dividing the difference in gallons by the time of discharge.

3. If an open top calibrated tank is used, discharge through the nozzle until the pressure stabilizes, and then simultaneously direct the stream into the tank while starting the stop watch. Stop the stop watch when the tank is full and remove or shut off the nozzle. Determine the flow rate by dividing the tank volume in gallons by the fill time in minutes.

(f) If the nozzle is the nonair-aspirated type, repeat steps (b) through (e) with the nozzle pattern setting in the fully dispersed position.

5-3.22.5 The measured hand line nozzle flow rates shall equal the specified flow rate within a tolerance of ± 5 percent.

5-3.23 Handline Nozzle Pattern Test. The hand line nozzle pattern test shall be conducted in accordance with the requirements of NFPA 412, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles*, and the results evaluated in accordance with the vehicle specifications.

5-3.24 Ground Sweep/Bumper Turret Flow Rate Test.

5-3.24.1 Test facilities shall consist of an open site suitable for discharging agent. Access to a refill water supply is required.

5-3.24.2 Test equipment shall consist of the following:

(a) A calibrated sight gage.

(b) Liquid volume measuring device accurate to within ± 1 percent.

(c) A calibrated pressure gage if not already provided on the truck.

5-3.24.3 It shall have been verified that the vehicle's pumping system is capable of operating at full rate.

5-3.24.4 The ground sweep/bumper turret discharge rate shall be determined as follows:

(a) Set the ground sweep/bumper turret pattern for straight stream operation.

(b) Fill water tank completely.

(c) Engage pump and bring up to design speed.

(d) Open ground sweep/bumper turret flow control valve.

(e) 1. If flow meters are used, read and record the flow rate once the discharge pressure stabilizes.

2. If a sight gage is used, read and record the tank volume in gallons while simultaneously starting a stop watch after the discharge pressure stabilizes. Read and record the tank volume in gallons when the watch is stopped after allowing flow for at least 1 minute. Determine the flow rate in gpm by dividing the difference in gallons by the time of discharge.

(f) If the ground sweep/bumper turret is the nonair-aspirated type, repeat steps (b) through (e) with the nozzle pattern setting in the fully dispersed position.

5-3.24.5 The measured flow rates shall equal the specified flow rate within a tolerance of +10 percent or −0 percent.

5-3.25 Ground Sweep/Bumpr Turret Pattern Test. The ground sweep/bumper turret pattern test shall be conducted in accordance with the requirements of NFPA 412,

Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles, and the results evaluated in accordance with the vehicle specifications.

5-3.26 Undertruck Nozzle Test.

5-3.26.1 The test facilities shall consist of an open site suitable for discharging agent.

5-3.26.2 Markers shall be available for use in defining the pattern boundaries.

5-3.26.3 It shall have been verified that the vehicle's pump system is capable of operating at full rate, and the agent tanks shall be filled with water and foam respectively.

5-3.26.4 The test shall be conducted as follows:

(a) The agent system shall be set to operate in the foam mode.

(b) The agent pumps shall be engaged and brought up to design speed.

(c) The undertruck nozzles shall be opened to discharge simultaneously, and discharge shall continue until a definite pattern outline is apparent.

(d) The discharge shall be closed, and the boundaries of the pattern marked and recorded.

5-3.26.5 The pattern is acceptable if the foam spray covers the outline created by the vehicle on the ground and wets the inside of all tires.

5-3.27 Foam Concentration/Foam Quality Test.

5-3.27.1 The test facilities shall consist of an open site suitable for discharging agent. Access to a refill water and foam concentrate supply is required.

5-3.27.2 The test equipment described in NFPA 412, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles,* shall be used for this test.

5-3.27.3 The vehicle shall have had each discharge nozzle individually verified to be discharging at a flow rate within the tolerance specified. The agent system shall have been verified as being capable of operating at full rate.

5-3.27.4 The test shall be conducted as follows:

(a) The water and foam tank shall be filled to the top and refilled as necessary throughout the test.

(b) The foam proportioning system shall be set to proportion foams at the concentration specified and the agent selector set for the foam mode.

(c) The agent system pressure relief shall be set to the recommended pressure.

(d) The agent pumps shall be engaged and brought up to maximum pumping speed with all discharge outlets closed.

(e) Each foam delivery system shall be tested as described in NFPA 412, first for the individual nozzle/flow rate listed below and then for a total combined simultaneous discharge:

- Roof turret(s) full rate
- Roof turret(s) half rate
- Ground sweep/bumper turret
- Hand line nozzles
- Undertruck nozzles

5-3.27.5 The foam concentrations measured shall fall within the allowed tolerances specified in NFPA 412 for each nozzle and for the combined simultaneous discharge. The foam expansion and drainage time measurements shall equal or exceed those specified in NFPA 412 for each nozzle.

5-3.28 Warning Siren Test.

5-3.28.1 The test facilities shall consist of a flat open area free from any large reflecting surfaces (such as other vehicles, signboards, or hills) within a 200 ft radius of the vehicle.

5-3.28.2 The test equipment shall consist of:

(a) A sound level meter that meets the requirements of the American National Standards Institute ANSI S1.4 Specifications for Sound Level Meters for Type 1 or S1A Meters. The sound level meter must have been calibrated by a certified testing laboratory within the last 12 month period.

(b) A tape measure.

5-3.28.3 The vehicle's siren speaker shall be mounted in its proper location and be in working order.

5-3.28.4 The capability of the warning siren on the vehicle to project sound forward and to the sides shall be determined as follows:

(a) Set the sound level meter to the A-weighing network, "fast" meter response, and position the meter directly ahead of the vehicle at a distance of 100 ft from the front bumper. The microphone shall be at ear level.

(b) Energize the siren and record the meter reading.

(c) Repeat steps (a) and (b) with the sound level meter 100 ft from the vehicle, first at a position 45° to the right and then 45° to the left of the longitudinal centerline of the vehicle.

5-3.28.5 The recorded noise level shall equal or exceed the specifications.

5-3.29 Propellant Gas.

5-3.29.1 Test facilities shall consist of an open site suitable for discharging AFFF, dry chemical, or Halon agent.

5-3.29.2 Test equipment shall consist of a calibrated scale or load cell with an accuracy of ± 1 percent.

5-3.29.3 The vehicle shall have its extinguishing agent piping system operational and shall have the agent tank(s) empty. Propellant gas tank(s) shall be fully charged and within proper pressure. A means of lifting the agent tanks for weighing without loss of agent shall be provided. Alternatively, the extinguishing agent tank(s) may be tested outside of the vehicle. Using this alternative, the test shall be conducted with agent tank(s) and related piping, fittings, valves, hose, and nozzle(s) in the same configurations as they will be installed on the vehicle.

5-3.29.4 The test for each of the extinguishing agents shall be conducted in the following manner:

(a) Weigh the empty tank(s) and record as tare weight.

(b) Using the manufacturer's recommended filling procedure, charge the tank(s) with the manufacturer's recommended extinguishing agent to the upper fill weight/volume tolerance. Reweigh and record this as gross filled weight.

(c) Ensure that all fill caps are securely tightened, all propellant gas lines are connected, discharge nozzle(s) are in the closed position, and that all fittings and connections are tight.

(d) Pressurize the agent tank(s) using the manufacturer's recommended procedure.

(e) Simultaneously, fully open all discharge nozzles and keep open until only the pressurizing gas is expelled.

(f) Shut down propellant gas supply.

(g) Reweigh the agent tank(s) and record this as post discharge weight.

(h) Calculate and record the total agent discharged as follows:

Gross Filled Weight - Post Discharge Weight = Total Agent Discharge

5-3.29.5 There shall be a sufficient supply of propellant gas to purge all discharge lines as evidenced by emission of gas only from each nozzle. The total agent discharged shall equal or exceed the design capacity.

5-3.30 Pressure Regulation.

5-3.30.1 Test facilities shall consist of an open site suitable for discharging the AFFF, dry chemical, or Halon agent.

5-3.30.2 Test equipment shall consist of a calibrated pressure gage or transducer capable of reading recommended tank top discharge pressure and possessing an accuracy of ± 5.0 psig.

5-3.30.3 The vehicle shall have its extinguishing agent system piped to all discharge outlets with the tank(s) empty. Propellant gas tanks shall be fully charged and at proper pressure. A means for mounting a pressure gage or transducer somewhere between the downstream (low pressure) side of the regulator and the agent tank top shall be provided. Alternatively, the extinguishing agent tank(s) may be tested outside of the vehicle. Using this alternative, the test shall be conducted with agent tank(s) and related piping, fittings, valves, hose, and nozzles in the same configuration as they will be installed on the vehicle.

5-3.30.4 The test for each of the extinguishing agents shall be conducted in the following manner:

(a) Using the manufacturer's recommended filling procedure, charge the tank(s) with the manufacturer's recommended extinguishing agent to the upper fill weight/(volume) tolerance.

(b) Install a pressure gage or transducer between the downstream (low pressure) side of the regulator and the agent tank top.

(c) Ensure that all fill caps are securely tightened, all propellant gas lines are connected, discharge nozzles are in the closed position and that all fittings are tight.

(d) Pressurize the agent tank(s) using the manufacturer's recommended procedure. Record agent tank pressure.

(e) Simultaneously fully open all discharge nozzles and keep open until only the pressurizing gas is expelled.

(f) During agent discharge, monitor agent tank pressure and record at 5 second intervals or less.

(g) Once the gas point has been reached for all discharge nozzles, shut down gas supply.

5-3.30.5 The pressure regulation system shall be capable of maintaining pressure throughout the discharge. At no time shall pressure fall below or exceed the design range specified by the manufacturer.

5-3.31 AFFF Premix Piping and Valves.

5-3.31.1 Test facilities shall consist of a level open site suitable for discharging the agent and measuring ranges.

5-3.31.2 Test equipment shall consist of:

(a) A calibrated scale or load cell with an accuracy of ± one percent.

(b) A stopwatch.

5-3.31.3 The vehicle shall have all foam discharge piping operational and shall have the premix tank empty. Propellant gas tank(s) shall be fully charged and within proper pressure. A means of lifting the agent tank(s) for weighing without loss of agent shall be provided. Alternatively, the system may be tested outside the vehicle. Using this alternative, the test shall be conducted with the premix tank and related piping, fittings, valves, hose, and nozzle(s) in the same configuration as they will be installed on the vehicle.

5-3.31.4 The test shall be conducted in the following manner:

(a) Weigh the empty premix tank and record as tare weight.

(b) Using the manufacturer's recommended filling procedure, charge the tank with water or premix solution. Reweigh and record as gross filled weight.

(c) Ensure that all fill caps are securely tightened, all propellant gas lines are connected, discharge nozzles are in the closed position, and that all fittings and connections are tight.

(d) Pull all hand line hose from reel(s) or hose compartment(s).

(e) Pressurize the system using the manufacturer's recommended procedure.

(f) Simultaneously start the stop watch and fully open all turret(s), undertruck nozzles, and hand line(s).

(g) After discharging for at least 30 seconds, simultaneously stop the stopwatch and close all turret(s), undertruck nozzles, and hand line(s). Record the elapsed time on the stopwatch as discharge time.

(h) Following manufacturer's instructions, shut off propellant gas supply and blow down the system.

(i) Reweigh the premix tank and record this as post discharge weight.

(j) Add the recommended flow rates from each discharge nozzle and record this sum as the designed total flow rate.

(k) Calculate actual total flow rate as follows:

$$\frac{\text{Gross filled weight} - \text{Post discharge weight}}{(\text{Density}) \times \frac{(\text{elapsed time in seconds})}{60}} = \text{actual total flow rate}$$

5-3.31.5 Actual total flow rate shall equal the specified designed total flow rate within a tolerance of + 10 percent or −0 percent.

5-3.32 Pressurized Agent Purging and Venting.

5-3.32.1 Test facilities shall consist of an open site suitable for discharging AFFF, dry chemical, or Halon agent.

5-3.32.2 No special test equipment or instrumentation are required to conduct the test(s).

5-3.32.3 The vehicle shall have its extinguishing agent system(s) fully operational and shall have the agent tank(s) fully charged with the manufacturer's recommended agent. Propellant gas tank(s) shall be fully charged and within proper pressure. Alternatively, the extinguishing agent tank(s) may be tested outside of the vehicle. Using this alternative, the test shall be conducted with fully charged agent tank(s) and related piping, fittings, valves, hose, and nozzle(s) in the same configuration as they will be installed on the vehicle.

5-3.32.4 The test for each of the pressurized extinguishing agent systems shall be conducted in the following manner:

(a) Pressurize the agent tank(s) using the manufacturer's recommended procedure.

(b) Pull all hose from reel(s) or compartment(s).

(c) Fully open all discharge devices.

(d) After approximately 5 to 20 seconds, close all discharge devices.

(e) Purge all discharge lines and vent agent tank(s) using the manufacturer's recommended procedure.

5-3.32.5 Agent beyond the tank outlet shall be purged from the discharge piping and hose as evidenced by gas only discharge from each nozzle. The depressurization or venting of the agent tank shall allow only minimal quantities of agent to escape.

5-3.33 Auxiliary Agent Hand line Flow Rate and Range.

5-3.33.1 Test facilities shall consist of a level open site suitable for discharging the dry chemical or Halon agent and measuring ranges. Wind conditions shall be calm (less than 5 mph).

5-3.33.2 Test equipment shall consist of the following:

(a) A calibrated scale or load cell with an accuracy of ± one percent.

(b) A stopwatch.

(c) A tape measure or other distance measuring device.

(d) A calibrated anemometer.

(e) A pan having at least 1 square foot of area containing either motor or aviation gasoline.

5-3.33.3 The vehicle shall have all agent piping operational and shall have the agent tank empty. Propellant gas tank(s) shall be fully charged and within proper pressure. A means of lifting the agent tank(s) for weighing without loss of agent shall be provided. Alternatively, the system may be tested outside the vehicle. Using this alternative, the test shall be conducted with the agent tank and related piping, fitings, valves, hose, and nozzle(s) in the same configuration as they will be installed on the vehicle.

5-3.33.4 The tests shall be conducted in the following manner:

(a) Using the manufacturer's recommended agent and filling procedure, charge the agent tank.

(b) Ensure that all fill caps are securely tightened, all propellant gas lines are connected, discharge nozzles are in the closed position, and that all fittings and connections are tight.

(c) Pull all hand line hose from reel(s).

(d) Pressurize the system using the manufacturer's recommended procedure and open all hand line nozzles until agent flow is observed. Close the nozzles.

(e) Weigh and record agent tank as the "initial weight."

(f) Position hand line nozzles at least 20 ft from the fire pan so that they may be discharged onto a flat grade with no stream obstructions. Ignite the fuel.

(g) Select one of the hand line nozzles. While holding it in a position 3 to 4 ft above ground level, simultaneously start the stopwatch and fully open the nozzle, and discharge agent onto fire.

(h) After at least 50 percent of the contents of the tank have been discharged, shut down the nozzle and stop the stopwatch. Record time as "elapsed discharge time no. 1."

(i) Reweigh agent tank and record this as "weight after first discharge."

(j) If a second nozzle is provided, repeat steps (a) through (h).

(k) While holding the 2 hand line nozzles in a fixed horizontal position 3 to 4 ft above ground level, simultaneously start the stopwatch and fully open both nozzles.

(l) After at least 50 percent of the contents of the tank have been discharged, simultaneously shut down both nozzles and stop the stopwatch. Record time as "elapsed discharge time no. 2."

(m) Reweigh the agent tank and record as "weight after second discharge."

(n) Calculate the flow rate from nozzle 1 as follows:

$$\frac{\text{Initial Weight (Test 1)- Initial Weight (Test 2)}}{\text{(Elapsed discharge time No. 1)}} = \text{Flow Rate}$$

(o) Calculate the flow rate from nozzle 2 as follows:

$$\frac{\text{Weight After First Discharge} - \text{Weight After Second Discharge}}{2 \times \text{(Elapsed Discharge Time No. 2)}} = \text{Flow Rate}$$

(p) If the second nozzle is of a different configuration the fire test shall be repeated for this nozzle.

5-3.33.5 Test results shall be evaluated as follows:

(a) Flow rate from each nozzle shall meet or exceed the requirement.

(b) Range from each nozzle shall meet or exceed the requirements as evidenced by extinguishment of the fire(s).

(c) When discharged simultaneously, the flows from nozzle 1 and nozzle 2 shall be within 10 percent of each other.

5-3.34 Dry Chemical Turret Flow Rate and Range.

5-3.34.1 Test facilities shall consist of a level open site suitable for discharging the agent and measuring range. The test shall be conducted in calm wind (less than 5 miles per hour).

5-3.34.2 Test equipment shall consist of the following:

(a) A calibrated scale or load cell with an accuracy of ± 1 percent.

(b) A stopwatch.

(c) A tape measure or other distance measuring device.

(d) A calibrated anemometer.

5-3.34.3 The vehicle shall have all dry chemical discharge piping operational and shall have the dry chemical tank empty. Propellant gas tank(s) shall be fully charged and within proper pressure. A means of lifting the agent tanks for weighing without loss of agent shall be provided. Alternatively, the system may be tested outside the vehicle. Using this alternative, the test shall be conducted with the tank and related piping, fittings, valves, hose, and nozzle(s) in the same configuration as they will be installed on the vehicle.

5-3.34.4 The tests shall be conducted in the following manner:

(a) Using the manufacturer's recommended agent and filling procedure, charge the tank.

(b) Ensure that all fill caps are securely tightened, all propellant gas lines are connected, discharge nozzles are in the closed position, and that all fittings and connections are tight.

(c) Pressurize the system using the manufacturer's recommended procedure and open the turret discharge valve until agent is observed. Close the valve.

(d) Weigh and record the agent tank as the "initial test weight."

(e) Position the dry chemical turret so that it may be discharged onto a flat grade with no stream obstructions. The turret shall be positioned to obtain maximum straight stream reach.

(f) Simultaneously, start the stopwatch and fully open the turret.

(g) During discharge, markers shall be placed at the far point where significant dry chemical strikes the ground (range marker) and at either side of the widest part of the pattern (width markers).

NOTE: The operator(s) placing the markers shall wear proper safety equipment for this task. The agent manufacturer's material safety data sheet should be consulted.

(h) After discharging at least 75 percent of the contents of the tank, simultaneously stop the stopwatch and shut down the turret. Record the elapsed time in seconds as discharge time.

(i) Measure the distance from the turret to the range marker and record as far point range.

(j) Measure the distance between the width markers and record as pattern width.

(k) Reweigh the agent tank and record as weight after discharge.

(l) Calculate the flow rate as follows:

$$\frac{\text{Initial Test Weight - Weight after Discharge}}{\text{Elapsed Discharge Time}} = \text{Flow Rate}$$

5-3.34.5 Stream range and pattern width shall equal or exceed the requirements. Discharge flow rate shall equal or exceed the requirement.

5-3.35 Cab Interior Noise Test.

5-3.35.1 The test facilities shall consist of a flat open paved area suitable for operating the vehicle at a constant speed of 50 mph (80 kph) that is free from any large reflecting surfaces (such as other vehicles, signboards, or hills) within a 50 ft (15 m) distance of the vehicle. The wind speed shall not exceed 15 mph (24 kph) during the test.