

NFPA 414

Standard for Aircraft Rescue and Fire-Fighting Vehicles

2007 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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Standard for

Aircraft Rescue and Fire-Fighting Vehicles

2007 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, and acted on by NFPA at its June Association Technical Meeting held June 4–8, 2006, in Orlando, FL. It was issued by the Standards Council on July 28, 2006, with an effective date of August 17, 2006, and supersedes all previous editions.

This edition of NFPA 414 was approved as an American National Standard on August 17, 2006.

Origin and Development of NFPA 414

In 1960, a tentative edition of this standard was adopted by the Association. The original document was further revised in 1962, 1963, 1964, 1965, 1967, 1968, 1969, 1970, 1975, and 1978.

In 1984, the standard was revised completely to identify three types of vehicles and to make the document easier to use. The text also was rewritten to conform with the NFPA *Manual of Style*.

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

Notable revisions to the 1995 edition included the removal of requirements for a separate category of rapid intervention vehicle.

The major change for the 2001 edition was the combination of major fire-fighting vehicles and combined agent vehicles. Additionally, a table provided many requirements concisely that were previously covered by numerous paragraphs.

The 2007 revision includes minor changes to the document plus the addition of a new chapter on interior access vehicles.

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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.

Committee Scope: This Committee shall have primary responsibility for documents on aircraft rescue and fire-fighting services and equipment, for procedures for handling aircraft fire emergencies, and for specialized vehicles used to perform these functions at airports, with particular emphasis on saving lives and reducing injuries coincident with aircraft fires following impact or aircraft ground fires. This Committee also shall have responsibility for documents on aircraft hand fire extinguishers and accident prevention and the saving of lives in future aircraft accidents involving fire.



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

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex F. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex F.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard specifies the minimum design, performance, and acceptance criteria for aircraft rescue and fire-fighting (ARFF) vehicles intended to transport personnel and equipment to the scene of an aircraft emergency for the purpose of rescuing occupants and conducting rescue and fire-fighting operations.

1.1.2 Vehicles without wheels, such as track, amphibious, or air-cushion types, are not covered by this standard.

1.2 Purpose.

1.2.1 The purpose of this standard is to specify features and components that, when assembled, produce an efficient and capable fire-fighting vehicle for both on-pavement and off-pavement performance. Off-pavement capability is important to ensure timely and effective response of these vehicles to aircraft accident sites located off paved surfaces. Fire-fighting capabilities are considered to be the minimum acceptable for 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 Requirements for All Aircraft Rescue and Fire-Fighting Vehicles — Responsibility of Contractors/Suppliers.

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

1.3.2 Manuals. The manufacturer shall supply at the time of delivery the following manuals in electronic format:

- (1) Operator's manual
- (2) Service manual
- (3) Parts manual

These manuals shall cover the entire vehicle and shall be in accordance with 1.3.2.1 through 1.3.2.3.9.

1.3.2.1 Operator's Manual.

1.3.2.1.1 Operating instructions shall include all information required for operation of the vehicle, vehicle components, fire-fighting systems, and integral vehicular options.

1.3.2.1.2 The location and function of all controls and instruments shall be covered by illustrations and descriptions.

1.3.2.1.3 These instructions, as a minimum, also shall include the following:

- (1) Complete description of the vehicle and special equipment
- (2) Preparation for use of the vehicle upon receipt
- (3) Daily maintenance and mission readiness checks to be performed by the operator
- (4) Periodic operator inspection

1.3.2.2 Service Manual. The service manual shall contain the regular maintenance schedule including operating hours, mileage, and cycle time.

1.3.2.2.1 The repair and overhaul instructions shall be factual, specific, concise, and clearly worded.

1.3.2.2.2 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.

1.3.2.2.3 The instructions also shall include data that include tolerances, specifications, and capacities.

1.3.2.2.4 Illustrations, wiring diagrams, and exploded views shall be used to clarify text and shall appear as close to the related text as possible.

1.3.2.2.5 Special tools needed for the repair and overhaul of the equipment shall be specified and illustrated.

1.3.2.2.6 The service manual shall contain a suitable index.

1.3.2.3 Parts Manual.

1.3.2.3.1 The parts list shall include illustrations and exploded views necessary for the proper identification of all parts, assemblies, and subassemblies.



1.3.2.3.2 Assemblies or components shall be shown in illustrations and shall be identified by reference numbers that correspond to the reference numbers in the parts list.

1.3.2.3.3 The size, thread dimensions, and special characteristics shall be given on all nonstandard nuts, bolts, washers, grease fittings, and similar items.

1.3.2.3.4 The parts identification manual shall provide the description and quantity of each item used per vehicle.

1.3.2.3.5 The parts identification manual shall contain a numerical index.

1.3.2.3.6 The vehicle manufacturer shall ensure that parts critical to the mission of the vehicle are shipped to the purchaser within 48 hours.

1.3.2.3.7 The original equipment manufacturers shall be disclosed to the owner if the vendor is unable to supply the necessary parts within 48 hours to allow local purchase of an equivalent part.

1.3.2.3.8 A qualified and responsible representative of the contractor shall instruct personnel specified by the purchaser in the operation, care, and maintenance of the vehicle delivered.

1.3.2.3.9 The purchasers shall specify provisions for training, including the location and duration, and shall agree on suitable training aids such as video tapes and training manuals.

1.3.3 Metal Finish.

1.3.3.1 All exposed ferrous metal surfaces that are not plated or of stainless steel or that are not otherwise treated to resist corrosion shall be cleaned thoroughly and prepared and shall be painted in the color(s) specified by the purchaser.

1.3.3.2 If nonferrous body components are furnished, the purchaser shall specify which surfaces are to be painted.

1.3.3.3 The paint, including the primer, shall be applied in accordance with the paint manufacturer's recommendation.

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

1.3.3.5 Dissimilar metals shall not be in contact with each other.

1.3.3.5.1 Metal plating or metal spraying of metals of dissimilar base to provide electromotively compatible abutting surfaces shall be permitted.

1.3.3.5.2 The use of dissimilar metals separated by suitable insulating material shall be permitted.

1.3.3.5.3 In systems where bridging of insulation materials by an electrically conductive fluid can occur, dissimilar metals shall not be permitted.

1.3.3.6 Materials that deteriorate when exposed to sunlight, weather, or operational conditions normally encountered during service shall not be used or shall have a means of protection against such deterioration that does not prevent compliance with performance requirements.

1.3.3.7 Protective coatings that chip, crack, or scale with age or extremes of climatic conditions or when exposed to heat shall not be used.

1.3.3.8 The use of proven, nonmetallic materials in lieu of metal shall be permitted, provided such use contributes to reduced weight, lower cost, or less maintenance and there is

no degradation in performance or increase in long-term operations and maintenance costs.

1.3.4 Lettering, Numbering, and Striping.

1.3.4.1 Vehicle numbering, lettering, and minimum 0.2 m (8 in.) wide reflective striping shall be provided in accordance with ASTM D 4956.

1.3.4.2 Striping shall be placed horizontally on the sides of the vehicle below the body centerline.

1.3.4.3 Vehicles shall display an identification number on each side and roof.

1.3.4.3.1 Side numbers shall be a minimum of 0.4 m (16 in.) in height.

1.3.4.3.2 Primary numbers shall be a minimum of 0.6 m (24 in.) in height and affixed with their base toward the front of the vehicle.

1.3.4.4 Numbering, lettering, and striping shall be in sharp contrast to the vehicle color.

1.3.5 Vehicle Information Data Plate. A data plate that contains all the information presented in Figure 1.3.5, as a minimum, shall be installed in the cab of the vehicle.

Manufacturer _____	
Vehicle (make and model year) _____ and _____	
Drive type: ☐ 4 × 4 ☐ 6 × 6 ☐ 8 × 8 ☐ 10 × 10	
The vehicle was tested to _____ degrees in both directions (table angle)	
Was a trip/slip rail used? ☐ No ☐ Yes	
If yes, height of rail [maximum 50 mm (2 in.)] _____ [mm (in.)]	
Date of test: _____	
Front axle loading*	_____ [kg (lb)]
Second axle loading*	_____ [kg (lb)]
3rd axle loading* (if applicable)	_____ [kg (lb)]
4th axle loading* (if applicable)	_____ [kg (lb)]
5th axle loading* (if applicable)	_____ [kg (lb)]
Tire manufacturer	_____
Tire model	_____
Tire pressure	_____ [kPa (psi)]
Front wheel track	_____ [cm (in.)]
Rear wheel track	_____ [cm (in.)]
Crew capacity	_____ (Number of personnel)
Fuel tank capacity	_____ [L (gal)]
Equipment allowance	_____ [kg (lb)]
Water tank capacity	_____ [L (gal)]
Foam tank capacity	_____ [L (gal)]
Auxiliary agent capacity (if applicable)	_____ [kg (lb)]

*The "loading" shall be in accordance with the definition of a fully loaded vehicle as presented in NFPA 414.

FIGURE 1.3.5 Aircraft Rescue and Fire-Fighting Vehicle Tilt Table Certification per NFPA 414.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 412, *Standard for Evaluating Aircraft Rescue and Fire-Fighting Foam Equipment*, 2003 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2003 edition.

NFPA 1961, *Standard on Fire Hose*, 2002 edition.

NFPA 1964, *Standard for Spray Nozzles*, 2003 edition.

2.3 Other Publications.

2.3.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI S1.4, *Specification for Sound Level Meters*, 1983.

2.3.2 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME *Boiler and Pressure Vessel Code*, 1992.

2.3.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D 4956, *Standard Specification for Retroreflective Sheeting for Traffic Control*, 1994.

2.3.4 NATO Publications. Global Engineering Documents, An IHS Company, 15 Inverness Way East, Englewood, CO 80112.

NATO Document, "Dynamic Stability Report — Allied Vehicle Testing Publication (AVTP)," 03-16W.

2.3.5 SAE Publications. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J551/2, *Test Limits and Methods of Measurement of Radio Disturbance Characteristics of Vehicles, Motorboats, and Spark-Ignited Engine-Driven Devices*, 1994.

SAE J994, *Standard on Alarm-Backup-Electric Laboratory Performance Testing*, 1993.

SAE J1908, *Electrical Grounding Practice*, 1996.

SAE J2180, *A Tilt Table Procedure for Measuring the Static Roll-over Threshold for Heavy Trucks*, 1993.

SAE J2181, *Steady State Circular Test Procedures for Trucks and Buses*, 1993.

2.3.6 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections. (Reserved)

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction. An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

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

3.2.4 Shall. Indicates a mandatory requirement.

3.2.5 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1 AFFE See 3.3.27.1.

3.3.2 Aggressive Tire Tread. See 3.3.63.1.

3.3.3 Air-Mechanical Brakes. See 3.3.14.1.

3.3.4 Air-Over-Hydraulic Brakes. See 3.3.14.2.

3.3.5 All-Wheel Drive. A vehicle with the ability to apply tractive power to all wheels.

3.3.6 Ambient Temperature. The temperature of the surrounding medium; usually used to refer to the temperature of the air in which a structure is situated or a device operates.

3.3.7* Angle of Approach. The measure of the steepest ramp that a fully loaded vehicle can approach.

3.3.8* Angle of Departure. The measure of the steepest ramp from which the fully loaded vehicle can depart.

3.3.9 Aqueous Film-Forming Foam (AFFF) Concentrate. See 3.3.27.1.

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

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

3.3.12 Axle Tread. See 3.3.63.2.

3.3.13* Bogie. A combination of two axles used to support the end of a vehicle.

3.3.14 Brakes.

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

3.3.14.2 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.

3.3.14.3 Service Brake. A system capable of decelerating the vehicle at a controlled rate to a desired, reduced speed or complete stop.



3.3.15* Center of Gravity. The point within a vehicle at which all of its weight can be considered to be concentrated.

3.3.16* Complementary Agent. Agents that provide unique extinguishing capability beyond the primary chosen agent.

3.3.17 Component Manufacturer's Certification. A signed application approval furnished by the component manufacturer that certifies that the component is approved as being properly installed or applied, or both, in the vehicle for its intended use, or the component complies with the respective construction criteria required by the standard.

3.3.18* Cooling Preheater Device. A device for heating the engine coolant so that the engine is maintained at a constant temperature.

3.3.19* Diagonal Opposite Wheel Motion. The measurement of the vertical movement relationship of the wheel and suspension travel.

3.3.20 Differential Global Positioning System (DGPS). See 3.3.61.3.1.

3.3.21 Driver's Enhanced Vision System (DEVS). See 3.3.61.1.

3.3.22 Dynamic Balance. A physical condition that exists when a vehicle is driven into a turn under high speed and the vehicle displays no tendencies to pitch weight forward on the front steering wheels nor exhibits of understeer or oversteer conditions which could make the vehicle unstable.

3.3.23 Equipment Allowance. Any equipment added to the vehicle that is not directly required for the vehicle to discharge water or other fire-fighting agent(s) on the initial attack.

3.3.24 Extendable Turret. See 3.3.64.1.

3.3.25 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 producing torque multiplication.

3.3.26 Fluoroprotein Foam Concentrate. See 3.3.27.2.

3.3.27 Foam Concentrate.

3.3.27.1 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.

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

3.3.27.3 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 otherwise to ensure readiness for use under emergency conditions.

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

3.3.29 Foam-Liquid Concentration. The quantity of foam-liquid concentrate in water identified in percentage.

3.3.30* Forward-Looking Infrared (FLIR). The detection of heat energy radiated by objects to produce a "thermal image."

This thermal image is converted by electronics and signal processing into a visual image that can be viewed by the operator.

3.3.31 Fully Loaded Vehicle. See 3.3.71.2.

3.3.32 Global Positioning System (GPS). See 3.3.61.3.

3.3.33 Ground Sweep Nozzle. See 3.3.42.1.

3.3.34 Halogenated Agents. Agents that are complementary agents including halocarbons and halons.

3.3.35 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.

3.3.36* Intended Airport Service. All aspects of aircraft rescue and fire-fighting services as provided by this standard.

3.3.37* 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 two axles.

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

3.3.39 "J" Turn Test. The measure of a vehicle's ability to traverse a 90 degree turn at a prescribed speed.

3.3.40 Lightweight Construction. Lightweight materials or advanced engineering or both practices resulting in a weight saving without sacrifice of strength or efficiency.

3.3.41 No-Load Condition. The status of 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.

3.3.42 Nozzle.

3.3.42.1 Ground Sweep Nozzle. A small nozzle(s) mounted in front of the vehicle that disperses foam solution in front to provide protection.

3.3.42.2 Undertruck Nozzle. A small nozzle device that hangs below the vehicle and disperses foam solution in a manner that provides protection for the vehicles from ground or grass proximity fires; these devices spray agent from wheel to wheel and front to back of the underside of the truck.

3.3.43* Off-Pavement Performance. A vehicle's ability to perform or operate on other than paved surfaces.

3.3.44 Operational Tests. An all-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.

3.3.45* Overall Height, Length, and Width. The dimensions determined with the vehicle fully loaded and equipped, unless otherwise specified.

3.3.46* Percent Grade. The ratio of the change in elevation to the horizontal distance traveled multiplied by 100.

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

3.3.48 Primary Turret. See 3.3.64.2.

3.3.49* Propellant Gas. A gas pressurizing an agent container.

3.3.50 Protein Foam Concentrate. See 3.3.27.3.

3.3.51 Prototype Vehicle. See 3.3.71.3.

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

3.3.53 Ramp Angle. See 3.3.37, Interaxle Clearance Angle (Ramp Angle).

3.3.54 Reserve Capacity Rating. The number of minutes a new, fully charged battery at 26.7°C (80°F) can be discharged at 25 amperes while maintaining 1.75 volts per cell or higher.

3.3.55* Rubber-Gasketed Fitting. A device for providing a leakproof connection between two pieces of pipe while allowing moderate movement of one pipe relative to the other.

3.3.56 Seat Belt. A two-point lap belt, a three-point lap/shoulder belt, or a four-point lap/shoulder harness for vehicle occupants designed to limit their movement in the event of an accident, rapid acceleration, or rapid deceleration by securing individuals safely to a vehicle in a seated position.

3.3.57 Service Brake. See 3.3.14.3.

3.3.58 Side Slope. This angle is measured as either the percent of slope or the tilt angle at which the vehicle would become unstable should the vehicle be placed on the side of a steep, angled hill or sloped surface.

3.3.59* Steering Drive Ends. In the front wheel spindle in a driving-steering axle as used at the front of an all-wheel drive vehicle.

3.3.60 Surfaces.

3.3.60.1 Improved Surfaces. Surfaces that are classed as main thoroughfares, paved roadways, runways, taxiways, parking aprons, and secondary routes of vehicle travel including mediums that are normally of paved, asphalted, or concrete construction.

3.3.60.2 Unimproved Surfaces. Surfaces that are not paved or surface coated for heavy automotive travel and include dirt, clay, shale, or crushed rock that is not maintained on a regular basis.

3.3.61 System.

3.3.61.1 Driver's Enhanced Vision System (DEVS). An enhanced vision and navigation system for guiding aircraft rescue and fire-fighting vehicles at night and during certain low-visibility conditions. The DEVS is comprised of three systems: (1) *Navigation*, which displays the ARFF vehicle's position on a moving map display mounted in the cab; (2) *Tracking*, which provides two-way digital communication between the ARFF vehicle and the Emergency Command Center; (3) *Vision*, which allows the ARFF vehicle operator to see in 0/0 visibility conditions.

3.3.61.2 Electronic Stability Control System. A closed-loop stability-control system that relies on proven antilock brake system and traction control system components. It incorporates sensors for determining vehicle parameters as well as an electronic control unit to modulate braking and traction forces.

3.3.61.3* Global Positioning System (GPS). A satellite-based radio navigation system comprised of three segments: space, control, and user.

3.3.61.3.1* Differential Global Positioning System (DGPS). A technique applied to a global positioning system (GPS) solution that improves the accuracy of that solution.

• **3.3.62 Torque Converter.** A device that is similar to a fluid coupling but that produces, by means of additional turbine blades, variable torque multiplication.

3.3.63 Tread.

3.3.63.1 Aggressive Tire Tread. Tread designed to provide maximum traction for all types of surfaces, including sand, mud, snow, ice, and hard surfaces, wet or dry.

3.3.63.2* Axle Tread. The distance between the center of two tires or wheels on one axle.

3.3.64 Turret.

3.3.64.1* Extendable Turret. A device, permanently mounted with a power-operated boom or booms, designed to supply a large-capacity, mobile, elevatable water stream or other fire-extinguishing agents, or both.

3.3.64.2* Primary Turret. The largest capacity foam turret used to apply primary extinguishing agent.

3.3.65* Twenty-Five 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.

3.3.66 Underaxle Clearance. The clearance distance between the ground and the center drive train of the vehicle; generally this measurement is taken at the low point bottom of the drive differentials.

3.3.67* Underbody Clearance Dimensions. The dimensions determined with the vehicle fully loaded and fully equipped, unless otherwise specified.

3.3.68 Undertruck Nozzle. See 3.3.42.2.

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

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

3.3.71 Vehicle.

3.3.71.1 Aircraft Interior Access Vehicle. A vehicle designed with the primary purpose of enabling access to an aircraft interior.

3.3.71.2* Fully Loaded Vehicle. Consists of the fully assembled vehicle, complete with a full complement of crew, fuel, and fire-fighting agents.

3.3.71.3* Prototype Vehicle. The first vehicle of a unique vehicle configuration built to establish its performance capability and the performance capability of all subsequent vehicles manufactured from its drawings and parts list.

3.3.72* Vehicle Types. Vehicle types are designated as 4 × 4, and so forth, and these designations are used to indicate the number of wheels on the vehicle and the number of wheels that propel or drive the vehicle.

3.3.73* Wall-to-Wall Turning Diameter. A measurement of the space that completely contains a vehicle as it is being turned.



3.3.74* Weather Resistant. Sufficiently protected to prevent the penetration of rain, snow, and wind-driven sand, dirt, or dust under all operating conditions.

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

3.3.76 Where Specified. Options selected by the purchaser beyond the minimum requirements of the standard.

Chapter 4 Aircraft Rescue and Fire-Fighting Vehicles

4.1* General.

4.1.1 The design criteria for the standard vehicles described by this document consider temperature extremes ranging from 0°C to 43.3°C (32°F to 110°F). For cold weather operation where temperatures periodically range from -40°C to 0°C (-40°F to 32°F) or lower, some type of winterization system is to be specified by the purchaser. Vehicles shall comply with Table 4.1.1(a), Table 4.1.1(b), Table 4.1.1(c), Table 4.1.1(d), and other requirements in this chapter.

4.1.2 The category of vehicles shall encompass a range of water capacity commencing at 454 L (120 gal) and extending to over 6000 L (1585 gal).

4.1.3* Certain vehicles shall be required to carry complementary agents in addition to carrying foam as the primary agent.

4.1.4 Because the same performance cannot be expected of all vehicles within this range, vehicles shall be classified by water capacity as listed in Table 4.1.1(a) and Table 4.1.1(b).

4.1.5* Additional vehicle options, where needed, shall be selected by the purchaser.

4.2 Weights and Dimensions.

4.2.1* Weights.

4.2.1.1 The actual gross vehicle weight of a fully staffed, loaded, and equipped vehicle ready for service shall not exceed the manufacturer's tested weight rating as recorded on the vehicle information data plate.

4.2.1.2* The weight shall be distributed as equally as practical over the axles and tires of the fully loaded vehicle.

4.2.1.2.1 The difference in weight between tires on any axle shall not exceed 5 percent of the average tire weight for that axle.

4.2.1.2.2 The difference in weight between any two axles shall not exceed 10 percent of the weight of the heaviest axle if the heavy axle is a rear axle.

4.2.1.2.3 If the heavy axle is a front axle, the weight difference between that axle and any other axle shall not exceed 5 percent of the heavy axle weight.

4.2.1.2.4 Under no circumstances shall the axle and tire manufacturers' ratings be exceeded.

4.2.1.3 The center of gravity of every vehicle shall be tested at the time of manufacture and kept as low as possible under all conditions of loading.

4.2.1.4 It shall be the end user's responsibility to ensure vehicles modified by the end user comply with performance requirements.

4.2.1.5 The vehicle also shall be driven on a steering pad around a circle and the steering wheel rotation shall increase with acceleration of speed to ensure the vehicle does not exhibit oversteer characteristics. (See 6.3.2.4 for test requirements.)

4.2.2 Dimensions.

4.2.2.1* The axle clearances in Table 4.1.1(a) and Table 4.1.1(b) shall be measured with vehicle tires inflated to highway inflation pressure.

4.2.2.1.1 The dimensions in Table 4.1.1(a) and Table 4.1.1(b) shall be permitted to be reduced to give more stable performance on hard pavement if the suspension is designed to raise the vehicle to these clearances when vehicle is traveling off pavement. Where an active suspension provides vehicle leveling and maintenance of the underbody clearance of the lower under-axle, clearances shown in the parentheses in Table 4.1.1(a) and Table 4.1.1(b) shall be used.

4.2.2.1.2 If this option is used, the vehicle shall be tested in accordance with Table 4.1.1(a) and Table 4.1.1(b).

4.2.2.2* The 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 Field of Vision.

4.2.2.3.1 The vehicle shall be constructed so that a seated driver, having an eye reference point of 80.7 cm (31¾ in.) above the seat cushion and 30.5 cm (12 in.) forward from the seat back, shall be able to see the ground 6.1 m (20 ft) ahead of the vehicle and shall have a field of vision of at least 5 degrees above the horizontal plane.

4.2.2.3.2 The field of vision in the horizontal plane shall be at least 90 degrees on each side from the straight ahead position and shall not create an obstruction of more than 7 degrees per obstruction.

4.2.2.4 Adjustable rearview mirrors with a glass area of not less than 387.1 cm² (60 in.²) shall be provided on each side of the vehicle.

4.2.2.4.1 Each side shall be provided with a minimum 45.2 cm² (7 in.²) wide-angle (convex) mirror.

4.2.2.4.2 Rearview outside mirrors shall be motorized and controlled from the driver's position.

4.2.2.4.3 Convex mirrors shall not be required to be motorized.

4.2.2.4.4 In lieu of mirrors, audiovisual devices that meet or exceed the field of vision provided by the wide-angle mirrors shall be permitted.

4.3 Engine.

4.3.1 Performance Requirements.

4.3.1.1 Engine Characteristics.

4.3.1.1.1 The vehicle engines shall have sufficient horsepower, torque, and speed characteristics to meet and maintain all vehicular performance characteristics specified in this standard.

4.3.1.1.2 The engine manufacturer shall certify that the installed engine is approved for this application.

Table 4.1.1(a) Fully Loaded Vehicle Performance Parameters (SI Units)

Performance Parameters	Minimum Usable Capacity		
	Vehicle Water Tank Capacity ≥454 to ≤1999 L	Vehicle Water Tank Capacity >1999 to ≤6000 L	Vehicle Water Tank Capacity >6000 L
Side slope stability (degrees)	30	30	30
Dynamic balance (kph), minimum speed on a (30 m) radius circle	40	35.5	35.5
Angle of approach (degrees)	30	30	30
Angle of departure (degrees)	30	30	30
Interaxle clearance (degrees)	12	12	12
Underbody clearance (cm)	33	46	46
Underaxle clearance at differential housing bowl (cm)	26.7	33.0 (26.7)	33
Diagonal opposite wheel motion (cm)	25.4	36	36
Wall-to-wall turning diameter	<Three times the vehicle's overall length	<Three times the vehicle's overall length	<Three times the vehicle's overall length
Maximum acceleration time from 0 to 80.5 kph (sec)	30	25	35
Top speed (kph)	≥113	≥113	≥113
Service brake: Stopping distance from 33 kph (m) from 64 kph (m) Percent grade holding of fully loaded vehicle: Ascending Descending	≤11 ≤40 m ≥50 percent ≥50 percent	≤11 ≤40 m ≥50 percent ≥50 percent	≤12 ≤49 m ≥50 percent ≥50 percent
Emergency brake stopping distance at 64 kph (m)	≤88	≤88	≤88
Parking brake: Percent grade holding for the parking brake Ascending Descending	≥20 percent ≥20 percent	≥20 percent ≥20 percent	≥20 percent ≥20 percent
Evasive maneuver test, NATO Document AVTP 03-16W (kph)	40	40	40
"J" turn test at 46 m radius (kph)	48	48	48

Table 4.1.1(b) Fully Loaded Vehicle Performance Parameters (U.S. Customary Units)

Performance Parameters	Minimum Usable Capacity		
	Vehicle Water Tank Capacity ≥120 to ≤528 gal	Vehicle Water Tank Capacity >528 to ≤1585 gal	Vehicle Water Tank Capacity >1585 gal
Side slope stability (degrees)	30	30	30
Dynamic balance (mph) minimum speed on a (100 ft) radius circle	25	22	22
Angle of approach (degrees)	30	30	30
Angle of departure (degrees)	30	30	30
Interaxle clearance (degrees)	12	12	12
Underbody clearance (in.)	13	18	18
Underaxle clearance at differential housing bowl (in.)	10.5	13 (10.5)	13
Diagonal opposite wheel motion (in.)	10	14	14
Wall-to-wall turning diameter	<Three times the vehicle's overall length	<Three times the vehicle's overall length	<Three times the vehicle's overall length
Maximum acceleration time from 0 to 50 mph (sec)	30	25	35
Top speed (mph)	≥70	≥70	≥70
Service brake: Stopping distance from 20 mph (ft) from 40 mph (ft) Percent grade holding of fully loaded vehicle: Ascending Descending	≤35 ≤131 ≥50 percent ≥50 percent	≤35 ≤131 ≥50 percent ≥50 percent	≤40 ≤160 ≥50 percent ≥50 percent
Emergency brake stopping distance at 40 mph (ft)	≤288	≤288	≤288
Parking brake: Percent grade holding for the parking brake Ascending Descending	≥20 percent ≥20 percent	≥20 percent ≥20 percent	≥20 percent ≥20 percent
Evasive maneuver test, NATO Document AVTP 03-16W (mph)	25	25	25
“J” turn test at 150 ft radius (mph)	30	30	30

Table 4.1.1(c) Agent System Performance Parameters (SI Units)

Performance Parameters	Minimum Usable Capacity		
	Vehicle Water Tank Capacity ≥454 to ≤1999 L	Vehicle Water Tank Capacity >1999 to ≤6000 L	Vehicle Water Tank Capacity >6000 L
1. Water tank percent of deliverable water			
a. On level ground	100 percent	100 percent	100 percent
b. On 20 percent side slope	85 percent	85 percent	85 percent
c. 30 percent ascending/descending grade	85 percent	85 percent	85 percent
2. Turret(s) discharge	Total flow rate can be achieved with handlines	Total flow rate can be achieved using a roof turret, extendable turret, bumper turret, or a combination thereof	Total flow rate can be achieved using a roof turret, extendable turret, bumper turret, or a combination thereof
2a. Roof turret:			
a. Total minimum flow rate (L/min) OR	≥227	≥2839	≥4731
Individual flow rate of the roof turret, if used in combination with a bumper turret (L/min)	N/A	≥1892	≥3785
b. Stream pattern/distances:			
i. Straight/far point (m)	≥46	≥58	≥70
ii. Dispersed/far point (m)	≥15	≥20	≥21
iii. Dispersed/width (m)	≥9	≥11	≥11
2b. Extendable turret:			
a. Individual flow rate of the extendable turret if used in combination with a bumper turret (L/min)	N/A	≥1892	≥3785
b. Stream pattern/distances:			
i. Straight/far point (m)	N/A	≥58	≥58
ii. Dispersed/far point (m)	N/A	≥20	≥21
iii. Dispersed/width (m)	N/A	≥11	≥11
2c. Bumper turret:	Can be used as the primary turret	See roof turret discharge rates	See roof turret discharge rates
a. Flow rate (L/min)	≥227	≥946	≥946
b. Straight stream distance (m)	≥46	≥46	≥46
c. Dispersed pattern distances:			
i. Far point (m)	≥15	≥15	≥15
ii. Width (m)	≥9	≥9	≥9
iii. Near point (m)	Within 9 m of front bumper	Within 9 m of front bumper	Within 9 m of front bumper
2d. Ground sweep nozzle:	Where specified	Where specified	Where specified
a. Flow rate (L/min)	N/A	≥378 to ≤1135	≥378 to ≤1135
b. Dispersed pattern distances:			
i. Far point (m)	N/A	≥9	≥9
ii. Width (m)	N/A	≥3.5	≥3.5
2e. Undertruck nozzle flow rate (L/min)	Where specified >57	Where specified >57	Where specified >57

Table 4.1.1(c) *Continued*

Performance Parameters	Minimum Usable Capacity		
	Vehicle Water Tank Capacity ≥454 to ≤1999 L	Vehicle Water Tank Capacity >1999 to ≤6000 L	Vehicle Water Tank Capacity >6000 L
2f. Piercing nozzle flow rate (L/min)	Where specified ≥946	Where specified ≥946	Where specified ≥946
3. Number of water/foam handlines required per vehicle (select from following)	1	2	2
3a. Woven jacket water/foam handline:			
a. Nozzle flow rate (L/min)	≥360	≥360	≥360
b. Straight stream distance (m)	≥20	≥20	≥20
c. Dispersed stream pattern:			
i. Range (m)	≥6	≥6	≥6
ii. Width (m)	≥4.5	≥4.5	≥4.5
d. Hose inside diameter (mm)	≥38	≥38	≥38
e. Hose length (m)	≥46	≥46	≥46
3b. Reeled water/foam handline:			
a. Nozzle flow rate (L/min)	360 (≥227 for dual agent lines)	360 (≥227 for dual agent lines)	360 (≥227 for dual agent lines)
b. Straight stream distance (m)	≥20	≥20	≥20
c. Dispersed stream pattern:			
i. Range (m)	≥6	≥6	≥6
ii. Width (m)	≥4.5	≥4.5	≥4.5
d. Hose length (m)	≥46 (≥30 for dual agent lines)	≥46 (≥30 for dual agent lines)	≥46 (≥30 for dual agent lines)
4. Complementary agent			
a. Capacity (kg)	≥45	≥45	≥45
4a. Dry chemical handline:	Where specified	Where specified	Where specified
a. Discharge rate (kg/sec)	≥2.3	≥2.3	≥2.3
b. Range (m)	≥7.5	≥7.5	≥7.5
c. Hose length (m)	≥30	≥30	≥30
4b. Dry chemical turret:	Where specified	Where specified	Where specified
a. Discharge rate (kg/sec)	≥7 and ≤10	≥7 and ≤10	≥7 and ≤10
b. Range (m)	≥30	≥30	≥30
c. Width (m)	≥5	≥5	≥5
4c. Dry chemical extendable turret	Where specified	Where specified	Where specified
a. Discharge rate (kg/sec)	≥5.5	≥5.5 and ≤10	≥5.5 and ≤10
b. Range (m)	≥30	≥30	≥30
c. Width (m)	≥5	≥5	≥5
4d. Halogenated agent handline:	Where specified	Where specified	Where specified
a. Discharge rate (kg/sec)	≥2.3	≥2.3	≥2.3
b. Range (m)	≥7.5	≥7.5	≥7.5
c. Hose inside diameter (mm)	≥25.4	≥25.4	≥25.4
d. Hose length (m)	≥30	≥30	≥30

Table 4.1.1(d) Agent System Performance Parameters (U.S. Customary Units)

Performance Parameters	Minimum Usable Capacity		
	Vehicle Water Tank Capacity ≥ 120 to ≤528 gal	Vehicle Water Tank Capacity >528 to ≤1585 gal	Vehicle Water Tank Capacity >1585 gal
1. Water tank percent of deliverable water			
a. On level ground	100 percent	100 percent	100 percent
b. On 20 percent side slope	85 percent	85 percent	85 percent
c. 30 percent ascending/descending grade	85 percent	85 percent	85 percent
2. Turret(s) discharge	Total flow rate can be achieved with handlines	Total flow rate can be achieved using a roof turret, extendable turret, bumper turret, or a combination thereof	Total flow rate can be achieved using a roof turret, extendable turret, bumper turret, or a combination thereof
2a. Roof turret:			
a. Total minimum flow rate (gpm) OR Individual flow rate of the roof turret, if used in combination with a bumper turret (gpm)	≥60 N/A	≥750 ≥500	≥1250 ≥1000
b. Stream pattern/distances:			
i. Straight/far point (ft)	≥150	≥190	≥230
ii. Dispersed/far point (ft)	≥50	≥65	≥70
iii. Dispersed/width (ft)	≥30	≥35	≥35
2b. Extendable turret:			
a. Individual flow rate of the extendable turret if used in combination with a bumper turret (gpm)	N/A	≥500	≥1000
b. Stream pattern/distances:			
i. Straight/far point (ft)	N/A	≥190	≥190
ii. Dispersed/far point (ft)	N/A	≥65	≥70
iii. Dispersed/width (ft)	N/A	≥35	≥35
2c. Bumper turret:	Can be used as the primary turret	See roof turret discharge rates	See roof turret discharge rates
a. Flow rate (gpm)	≥60	≥250	≥250
b. Straight stream distance (ft)	≥150	≥150	≥150
c. Dispersed pattern distances:			
i. Far point (ft)	≥50	≥50	≥50
ii. Width (ft)	≥30	≥30	≥30
iii. Near point (ft)	Within 30 ft of front bumper	Within 30 ft of front bumper	Within 30 ft of front bumper
2d. Ground sweep nozzle:	Where specified	Where specified	Where specified
a. Flow rate (gpm)	N/A	≥100 to ≤300	≥100 to ≤300
b. Dispersed pattern distances:			
i. Far point (ft)	N/A	≥30	≥30
ii. Width (ft)	N/A	≥12	≥12
2e. Undertruck nozzle flow rate (gpm)	Where specified >15	Where specified >15	Where specified >15

Table 4.1.1(d) *Continued*

Performance Parameters	Minimum Usable Capacity		
	Vehicle Water Tank Capacity ≥ 120 to ≤528 gal	Vehicle Water Tank Capacity >528 to ≤1585 gal	Vehicle Water Tank Capacity >1585 gal
2f. Piercing nozzle flow rate (gpm)	Where specified ≥250	Where specified ≥250	Where specified ≥250
3. Number of water/foam handlines required per vehicle (select from following)	1	2	2
3a. Woven jacket water/foam handline:			
a. Nozzle flow rate (gpm)	≥95	≥95	≥95
b. Straight stream distance (ft)	≥65	≥65	≥65
c. Dispersed stream pattern:			
i. Range (ft)	≥20	≥20	≥20
ii. Width (ft)	≥15	≥15	≥15
d. Hose inside diameter (in.)	≥1.50	≥1.50	≥1.50
e. Hose length (ft)	≥150	≥150	≥150
3b. Reeled water/foam handline:			
a. Nozzle flow rate (gpm)	95 (≥60 for dual agent lines)	95 (≥60 for dual agent lines)	95 (≥60 for dual agent lines)
b. Straight stream distance (ft)	≥65	≥65	≥65
c. Dispersed stream pattern:			
i. Range (ft)	≥20	≥20	≥20
ii. Width (ft)	≥15	≥15	≥15
d. Hose length (ft)	≥150 (≥100 for dual agent lines)	≥150 (≥100 for dual agent lines)	≥150 (≥100 for dual agent lines)
4. Complementary agent			
a. Capacity (lb)	≥100	≥100	≥100
4a. Dry chemical handline:	Where specified	Where specified	Where specified
a. Discharge rate (lb/sec)	≥5	≥5	≥5
b. Range (ft)	≥25	≥25	≥25
c. Hose length (ft)	≥100	≥100	≥100
4b. Dry chemical turret:	Where specified	Where specified	Where specified
a. Discharge rate (lb/sec)	≥16 and ≤22	≥16 and ≤22	≥16 and ≤22
b. Range (ft)	≥100	≥100	≥100
c. Width (ft)	≥17	≥17	≥17
4c. Dry chemical extendable turret:	Where specified	Where specified	Where specified
a. Discharge rate (lb/sec)	≥12	≥12 and ≤22	≥12 and ≤22
b. Range (ft)	≥100	≥100	≥100
c. Width (ft)	≥17	≥17	≥17
4d. Halogenated agent handline:	Where specified	Where specified	Where specified
a. Discharge rate (lb/sec)	≥5	≥5	≥5
b. Range (ft)	≥25	≥25	≥25
c. Hose inside diameter (in.)	≥1.00	≥1.00	≥1.00
d. Hose length (ft)	≥100	≥100	≥100

4.3.1.2* The fully loaded vehicle shall be able to accelerate consistently from 0 kph to 80.5 kph (0 mph to 50 mph) on dry, level concrete pavement at the operational airport within the times specified in Table 4.1.1(a) and Table 4.1.1(b).

4.3.1.2.1 The maximum speed shall not be less than 112 kph (70 mph).

4.3.1.2.2 The acceleration times provided in Table 4.1.1(a) and Table 4.1.1(b) shall be achieved with the engine and transmission at their normal operating temperatures at any ambient temperature from -17.8°C to 43.3°C (0°F to 110°F) and at elevations up to 609.6 m (2000 ft) above sea level, unless a higher elevation is specified.

4.3.1.2.3 For airports above 609.6 m (2000 ft), the elevation at which the vehicle shall operate in order to ensure the necessary performance shall be specified.

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

4.3.2 Engine Cooling Systems.

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

4.3.2.2 This device shall be fitted with an automatic thermostat.

4.3.2.3 If the engine coolant preheating device requires electrical power from an outside source to operate, a grounded ac receptacle shall be provided to allow a pull-away connection from the local electric power supply to the engine coolant preheating device.

4.3.2.3.1 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.

4.3.2.3.2 The cooling system shall be provided with an automatic thermostat for rapid engine warming.

4.3.2.3.3 Where specified, radiator shutters, where furnished for cold climates, shall be of the automatic type and shall be designed to open automatically upon failure.

4.3.3 Fuel System.

4.3.3.1 A complete fuel system installed with the engine manufacturer's 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.

4.3.3.2 Gasoline engines shall have an electric fuel pump located near the fuel tank to prevent vapor lock.

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

4.3.3.3.1 A heated fuel/water separator equipped with a manual drain shall be supplied where the vehicle is equipped with a diesel-fueled engine.

4.3.3.3.2 The fuel/water separator shall meet the engine manufacturer's requirements.

4.3.3.4 Fuel tanks shall not be installed in a manner that allows gravity feed.

4.3.3.5 Fuel Capacity.

4.3.3.5.1 The fuel tank shall have sufficient capacity to provide for a minimum of 48.3 km (30 mi) of highway travel at 88.5 kph (55 mph) plus 2 hours of pumping at the full rated discharge.

4.3.3.5.2 Additional fuel capacity shall be provided for a minimum of 4 hours of operation of each accessory item (such as a generator or fuel-fired heaters) that uses the common fuel tank as a source.

4.3.4 Exhaust System.

4.3.4.1 The exhaust system shall be of a size that avoids undue back pressure and shall be located and constructed in such a manner that entrance of exhaust gases into the cab is minimized under all conditions of operation.

4.3.4.1.1 The exhaust system shall be of high-grade, rust-resistant materials.

4.3.4.1.2 The exhaust system shall include a muffler to reduce engine noise.

4.3.4.2 The exhaust system shall be protected from damage that could result from traversing rough terrain.

4.3.4.3 The tail pipe 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 Electrical Systems and Warning Devices.

4.4.1.1 Low-voltage electrical systems and warning devices shall comply with NFPA 1901, Chapter 13. (*See Annex B.*)

4.4.1.2 Line Voltage Electrical Systems. See Annex C.

4.4.2 Battery Chargers.

4.4.2.1 A built-in battery charger shall be provided on the vehicle to maintain full charge on all batteries.

4.4.2.2 A grounded ac receptacle shall be provided to allow a pull-away connection from the local electric power supply to the battery charger.

4.4.3 The electrical grounding procedures used on the vehicle shall be in accordance with SAE J1908 or an equivalent electrical grounding standard.

4.4.4 The fire-fighting system shall be on an independent circuit and shall not be jeopardized by the failure of the ancillary systems.

4.4.5 Where specified, an onboard battery charger/conditioner shall be provided on the vehicle and shall have a minimum output rating of one-half percent of the cold-cranking ampere rating at 0°C (32°F) of the engine-starting battery system.

4.4.5.1 The battery charger shall be supplied from an external power source of 115 volts or 220 volts ac.

4.4.5.2 This battery charger/conditioner shall be the type that can be connected to the batteries at all times and yet maintain a charge to the batteries without causing any damage.

4.4.5.3 The unit shall reduce its charging output level to a point where a small amount of charge is allowed to the batteries continuously or it shall shut off completely.

4.4.5.4 The charger/conditioner shall have protection built into it to protect it from damage during high current demands such as those caused by starting the engine.

4.4.5.5 The unit shall be provided with a grounded ac receptacle to allow a pull-away connection from the local electrical power supply to the battery charger/conditioner.

4.4.6 The electrical system and its components shall be weatherproof, insulated, and protected from chafing, damage from road debris, and exposure to ground fires.

4.4.6.1 All wiring shall be coded to correspond with the wiring diagram provided with the vehicle.

4.4.6.2 Circuit protection shall be provided to protect the vehicle in the event of electrical overload.

4.4.7 Radio suppression of the electrical system shall be in accordance with SAE J551/2 or an equivalent radio suppression standard.

4.5 Vehicle Drive. Transmission of power from the engine to the wheels of the vehicle shall be through an automatic or a semi-automatic gearbox.

4.5.1 The entire drivetrain 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.

4.5.2 The transmission shall be matched to the engine properly and shall be approved for the application.

4.5.3 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.

4.5.4 A positive drive shall be provided to each wheel by means of a fully locked driveline in order to maximize traction on low-friction surfaces.

4.5.4.1 Positive drive either shall be permitted to be achieved by the use of automatic locking and torque proportioning differentials or shall be permitted to be selected manually by the seated driver by use of a single control while the vehicle is in motion.

4.5.4.2 Where a 10 × 8 vehicle is used, only 8 of the 10 wheels shall be required to be powered.

4.5.5 All-Wheel Drive.

4.5.5.1 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.

4.5.5.2 An interaxle differential shall be installed with automatic means or driver-selected means of differential locking.

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

4.5.7 Axle Capacity.

4.5.7.1 Front and rear axles shall have adequate capacity to carry the maximum imposed load under all intended operating conditions.

4.5.7.2 The variations in axle track shall not exceed 20 percent of the tire(s) sectional width at rated load.

4.6* Suspension. The suspension system shall be designed to allow the loaded vehicle to perform as follows:

- (1) Travel at the specified speeds over improved surface
- (2) Travel at moderate speeds over unimproved surface

- (3) Provide diagonally opposite wheel motion above ground obstacles without raising the remaining wheels from the ground, in accordance with Table 4.1.1(a) and Table 4.1.1(b)

- (4) Prevent damage to the vehicle caused by wheel movement

4.7 Rims, Tires, and Wheels.

4.7.1 Vehicles shall be required to meet the specified paved surface performance while still providing off-pavement performance compatible with the conditions encountered at the operational airport, and tires shall be selected accordingly.

4.7.2* A tire selection shall be made that reflects the off-pavement performance requirements necessitated by the soil conditions encountered at the operational airport.

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

4.7.4 Vehicle and tire manufacturers shall be consulted for the tread design most suitable for the specific soil composition at individual airports. Only new tires shall be mounted on the vehicles; retreads shall not be permitted.

4.7.5 All wheels on the vehicle shall be of the single-wheel type, with all rims, tires, and wheels of an identical size and the same tire tread design. This requirement shall not apply to vehicles with a capacity of up to 500 gallons.

4.7.6 Rims, tires, and wheels shall be certified by their respective manufacturers as having sufficient capacity to meet the specified performance and shall be certified for not less than 42.9 km (25 mi) of continuous operation at 96.5 kph (60 mph) when inflated at the normal operational pressure.

4.8* Towing Connections. At least two large tow eyes or tow hooks (one at the front and one at the rear), capable of towing the vehicle on level ground without damage, shall be mounted on the truck and attached directly to the frame structure or where recommended by the vehicle manufacturer.

4.9 Brakes.

4.9.1* The braking system shall feature service, emergency, and parking brake systems. Service brakes shall be of the power-actuation air, hydraulic, or air-over-hydraulic type. 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. An ABS braking system shall be provided on the vehicle.

4.9.2* 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.

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

4.9.2.2 For vehicles less than 6000 L (1585 gal), the service brakes shall stop the vehicle within 10.7 m (35 ft) at 32.2 kph (20 mph) and within 39.9 m (131 ft) at 64.4 kph (40 mph).

4.9.2.3 For vehicles greater than 6000 L (1585 gal), the service brakes shall stop the vehicle within 12.2 m (40 ft) at 32.2 kph (20 mph) and within 48.8 m (160 ft) at 64.4 kph (40 mph).

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

4.9.2.5 For each vehicle, the service brakes shall provide one power-assisted stop while the vehicle engine is inoperative for the stopping distances specified in 4.9.2.2 through 4.9.2.4.

4.9.3 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. When a single failure in the service brake system of a part designed to contain compressed air or brake fluid occurs, other than failure of a common valve, manifold, brake fluid housing, or brake chamber housing, the vehicle shall stop within no more than 87.8 m (288 ft) at 64.4 kph (40 mph) without any part of the vehicle leaving a dry, hard, approximately level roadway that has a width equal to the vehicle width plus 1.2 m (4 ft).

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

4.9.5 Brakes — Air System.

4.9.5.1 Where the vehicle is supplied with air brakes, the air compressor shall meet the following criteria:

- (1) The compressor shall be engine driven.
- (2) The compressor shall have sufficient capacity to increase air pressure in the supply and service reservoirs from 586.1 kPa to 689.5 kPa (85 psi 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.
- (3) The compressor shall have the capacity for quick buildup from 0 kPa (0 psi) to release spring brakes, and this buildup in pressure shall be accomplished within 15 seconds.
- (4) The compressor shall incorporate an automatic air-drying system immediately downstream from the compressor to prevent condensation buildup in all pneumatic lines.

4.9.5.2 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, a proportionately longer buildup time shall be allowed using the following formula:

$$\frac{\text{actual reservoir capacity} \times 25}{\text{required reservoir capacity}} = \text{buildup time}$$

4.9.5.3 Reservoirs shall be equipped with drain valves and safety valves.

4.9.5.4 Provision shall be made for charging of air tanks with either a pull-away electrical connection used to power a vehicle-mounted complementary compressor or a pull-away air connection for charging of air tanks from an external air source.

4.9.5.5 Visual and audible low air pressure warning devices shall be provided. The low air pressure warning device shall be visual and audible to the driver from inside the cab of the vehicle.

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 allow 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 66.7 N (15 lbf) pull is needed 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 three times the vehicle length.

4.11 Cab. All interior crew and driving compartment door handles shall be designed and installed to protect against accidental or inadvertent opening.

4.11.1 The cab shall be fully enclosed (i.e., floor, roof, and four sides). Seating for the crew 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, two designated seat positions shall be provided, one for the driver and one for an additional crew member. Three-point seat belts equipped with a single hand hookup 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. Doors that open to as wide a position as possible shall be provided on each side of the cab with the necessary steps and handrails to allow rapid and safe entrance and exit from the cab. Each door shall be equipped with a sufficient restraint device(s) to prevent the door from being sprung by wind or jet blast. The 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 from dripping on the windshield and side windows. Where equipped with a primary turret having manual controls above the cab roof, the cab shall be designed with a quick-access passage to the primary 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 any seated position shall not exceed 85 dBA while traveling at 80.5 kph (50 mph) on a level, hard surface without warning devices operating; and while stationary, discharging water or foam from the high-volume turrets with exterior warning devices operating, the maximum limit shall be 90 dBA. The cab shall be permitted to be of the unitized rigid body and frame structure type, or it shall be permitted to 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 vehicle rollover accidents.

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 in front of the driver. All fire-fighting system instruments, warning lights, and controls shall



be grouped together by function to provide ready accessibility and high visibility for the driver as well as crew members.

4.11.4.2* All instruments and controls shall be illuminated, and backlighting shall 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 shall 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:

- (1) Speedometer/odometer
- (2) Engine tachometer(s)
- (3) Fuel level
- (4) Air pressure
- (5) Engine(s) temperature
- (6) Fire system pressure
- (7) Water tank level
- (8) Foam-liquid tank level
- (9) Low air pressure warning
- (10) Headlight beam indicator
- (11) Engine(s) oil pressure
- (12) Voltmeter(s)
- (13) Transmission oil temperature
- (14) Inclinator and a lateral G-force indicator; or an electronic stability control system; or both
- (15) Forward looking infrared (FLIR) monitor

In 4.11.4.4(4), (6), (7), (8), and (9), this component shall not be applicable to small commercial chassis.

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 the pumping system. The following cab controls shall be provided:

- (1) Accelerator pedal
- (2) Brake pedal
- (3) Parking brake control
- (4) Steering wheel, with directional signal control and horn
- (5) Transmission range selector
- (6) Pump control or selector
- (7) Foam control
- (8) Siren switch(es)
- (9) Bumper turret controls or ground sweep valve control, where specified
- (10) Undertruck valve control, where specified
- (11) Remote turret controls, where remote turret is provided
- (12) Light switches
- (13) Windshield wipers with delayed and multispeed capability and washer controls
- (14) Heater/defroster controls
- (15) Master electrical switch
- (16) Means of starting and stopping engine
- (17) Complementary agent pressurization control, where specified
- (18) Windshield deluge system switch, where specified

4.11.4.6 Where specified, a windshield deluge system shall be included to cool the windshield and to provide operator visibility during fire-fighting operations. It shall be designed to flood the windshield with clear water when activated. Clear water shall be discharged under sufficient pressure and in a pattern that ensures the driver/operator's field of vision can be kept clear of foam solution where used in conjunction with

the windshield wiper. The windshield wipers shall be energized automatically whenever the deluge system is operated.

4.11.4.7* Where specified, vehicles shall be equipped with the navigation system of a driver's enhanced vision system (DEVS).

4.11.4.7.1 The ARFF vehicle's position shall be displayed on a moving map display that shall be mounted in the cab. The vehicle's position shall be displayed within an accuracy of 2 m (6.56 ft), as well as the direction of travel. The map shall automatically pan and reorient itself to show the area around the vehicle.

4.11.4.8* A low-visibility enhanced vision system shall be installed in the vehicle. This system shall consist of a FLIR camera, monitor, and controlling devices, and shall provide the operator with a thermal image to provide assistance in driving under low-visibility conditions.

4.11.4.8.1 The FLIR shall have automatic gain and level controls and minimum horizontal fields of view (HFOV) of 27 degrees $\pm$ 4 degrees and vertical fields of view (VFOV) of 18 degrees $\pm$ 4 degrees, respectively. The FLIR shall be permitted to be a cooled or uncooled camera but shall be able to detect long wave (8 μ m to 12 μ m) infrared (IR) energy and have industry standard output.

4.11.5 Equipment.

4.11.5.1 The following equipment shall be provided in or on the cab, as applicable:

- (1) Heater/defroster
- (2) Driver's suspension seat with vertical, fore and aft adjustment, with seat belt (The use of a nonsuspension driver's seat shall be permitted where recommended by the manufacturer.)
- (3) Crew seats with individual retractable seat belts
- (4) Windshield washers appropriate for removing foam
- (5) Windshield wipers appropriate for removing foam
- (6) Siren
- (7) Horn
- (8) Sun visors, interior transparent
- (9) Outside rearview mirrors, as specified in 4.2.2.4
- (10) Interior lighting
- (11) Provisions for mounting self-contained breathing apparatus (SCBA) of the type specified by the purchaser at each crew seat position
- (12) Low-visibility forward-looking infrared device meeting suggested specifications contained in Section E.4 or equivalent

4.11.5.2 Where tools, equipment, or self-contained breathing apparatus (SCBA) are carried within enclosed seating areas of fire department vehicles, such items shall be secured by either a positive mechanical means of holding the item in its stored position or in a compartment with a positive latching door. The means for holding the item in place or in the compartment shall be designed to minimize injury to persons in the enclosed area of the vehicle caused by loose equipment during travel and, in the event of an accident, a rapid deceleration or a rapid acceleration.

4.11.6 Signs that state "Occupants must be seated and wearing a seat belt when apparatus is in motion" shall be provided. Such signs shall be visible from each seated position. An accident prevention sign shall be located at the rear step area of the vehicle, if it exists. It shall warn personnel that standing on the step while the vehicle is in motion is prohibited.

4.11.7* Where specified, a monitoring and data acquisition system (MADAS) shall be installed for the collection of various performance measurements to monitor, as a minimum, the following:

- (1) Vehicle speed
- (2) Vehicle heading
- (3) Lateral acceleration
- (4) Vertical acceleration
- (5) Longitudinal acceleration and deceleration
- (6) Engine rpm
- (7) Throttle position
- (8) Steering input
- (9) Vehicle braking input (pedal position and brake pressure)
- (10) Date, time, and location for all data collected

4.11.7.1 The data acquisition system shall be capable of storing the measurements and the time intervals, starting at least 120 seconds before and ending at least 15 seconds after any serious incident. The system shall be designed so that the data being recorded will not be lost or overwritten immediately after the incident due to the use of an emergency shutoff or a master electrical disconnect switch.

4.11.8* A lateral acceleration indicator that is adjustable for sensitivity and that provides both visual and audio signals and warnings to the driver shall be provided.

4.12 Body.

4.12.1 The body shall be constructed of materials that are of the lightest weight consistent with the strength necessary for off-pavement operation over rough terrain and where exposed to excess heat. The body shall be permitted to be of the unitized-with-chassis-rigid-structure type, or it shall be permitted to be flexibly mounted on the vehicle chassis. It also shall 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 that are inspected frequently. In particular, access doors of sufficient size and number shall be provided for access to the following:

- (1) Engine
- (2) Pump
- (3) Foam proportioning system
- (4) Battery storage
- (5) Fluid reservoirs

Other areas that need to be accessible for inspection or maintenance shall be open or shall 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. Compartments shall be weather resistant and self-draining.

4.12.4 A working deck shall be provided and shall be reinforced adequately to allow the crew to perform its duties in the primary turret area, cab hatch area, water tank top fill area and foam-liquid top fill area, and in other areas where access to complementary or installed equipment is necessary. The working deck shall be constructed of, or covered with, a slip-resistant material.

4.12.5 Handrails or bulwarks shall be provided where necessary for the safety and convenience of the crew. Rails and stanchions shall be braced strongly and constructed of a material

that is durable and resists corrosion. Handrails shall be constructed of, or covered with, a slip-resistant material.

4.12.6 Steps or ladders shall be provided for access to the top fill area. The lowermost step(s) shall be permitted to extend below the angle of approach or departure or ground clearance limits if it is designed to swing clear. All other steps shall be rigidly constructed. All steps shall be constructed of, or covered with, a slip-resistant material. The lowermost step(s) shall be no more than 558.8 mm (22 in.) 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 Vehicle numbering, lettering, and minimum 20.3 cm (8 in.) wide reflective striping shall be provided in accordance with ASTM D 4956. Striping shall be placed on at least 60 percent of the perimeter length of each side, width, and rear. At least 40 percent of the perimeter width of the front of the vehicle shall have the reflective stripe.

4.12.8.1 A graphic design meeting the reflectivity requirements of this subsection shall be permitted to replace all or part of the required striping, provided the design or combination thereof covers a minimum of the same perimeter length required in 4.12.8.

4.12.9 Attachments shall be provided for all tools, equipment, and other items that the purchaser specifies to be furnished on the vehicle. Equipment holders shall be attached firmly and designed so that equipment remains in place under all operating conditions, but the equipment shall be quickly removable for use.

4.12.10* Each storage compartment identified by the vehicle manufacturer for use by the purchaser shall be labeled with tested weight. Compartment loading shall not be exceeded as identified at the time of vehicle manufacture. Provision shall be made for mounting tools and equipment, as specified by the purchaser, on the truck. Special tools for servicing the vehicle, fire suppression system, and any of the auxiliary equipment shall be furnished as necessary by the vehicle manufacturer. Altering locations of tools and equipment will have an effect on vehicle stability.

4.13 Fire-Fighting Systems and Agents.

4.13.1 For ARFF purposes, vehicles using primary extinguishing agents shall be tested in accordance with NFPA 412.

4.13.2 Vehicles designed to discharge complementary agents shall require the use of complementary agents that are compatible with the primary agent.

4.13.3 All components of the agent systems, including such items as the tanks, piping, fill troughs, and screens, shall be made of materials resistant to corrosion by the primary agent, primary agent/water solution, water, and, where specified, the complementary agent.

4.13.4 Combinations of high pressure lines, valves, and quick disconnect fittings that allow for the in-service refilling of propellants without requiring the removal of the high pressure vessels from the truck shall be permitted.

4.14 Agent Pump(s) and Pump Drive.

4.14.1 Agent Pump(s).

4.14.1.1 The water pump(s) shall be constructed of corrosion-resistant metals and shall be of the single-stage or multiple-stage



centrifugal type and shall be designed for dependable emergency service. Pumps shall be designed carefully 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.

4.14.1.2 All proportioning system components shall be made of materials resistant to corrosion by all primary agents.

4.14.1.3 Where discharging foam solution, the pumping system shall be capable of discharging at a rate equal to or exceeding the total requirements of the roof or extendable turret(s), bumper turret or ground sweep nozzles, handline nozzles, and undertruck nozzles, where specified, discharging simultaneously at designed pressures.

4.14.2 Pump Drive.

4.14.2.1 The pump(s) drive shall allow 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 and shall minimize lurching of the vehicle when the vehicle drive is engaged during pumping operations. 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.

4.14.2.2 While pumping at rated capacity, the drive shall allow controlled vehicle operation at speeds from 0 kph to a minimum of 16.1 kph (0 mph to a minimum of 10 mph) in forward direction and 0 kph to a minimum of 8 kph (0 mph to a minimum of 5 mph) in rearward direction. During shifting from forward to rearward drive, the pumping system shall maintain the preset discharge pressure. The pump(s) drive shall have sufficient power capacity to provide the pump(s) discharge requirements of 4.14.1.3 while the vehicle is being propelled under all operating conditions where a fire-fighting capability is needed.

4.14.2.3 If an independent engine is used to drive the pump(s), 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 also shall be provided with a cooling system that meets the requirements of 4.3.2.

4.14.3 Tank-to-Pump Connections.

4.14.3.1 The tank-to-pump system shall be designed for efficient flow at the pumping rates required by 4.14.1.3. The pump suction line(s) shall be of large diameter and of the shortest length consistent with the most suitable pump location. A drain shall be at the lowest point with a valve for draining all of the liquid from the pumping system where desired. Tank-to-pump lines and valves shall be constructed of corrosion-resistant materials.

4.14.4 Discharge Connections. All couplings shall be specified by the purchaser to the standard for the airport.

4.14.5 Piping, Couplings, and Valves.

4.14.5.1 All piping, couplings, and valves shall be sized for necessary flow with minimum restriction and pressure loss.

Material for all piping, couplings, and valves shall be selected to avoid corrosive or galvanic action.

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

4.14.5.3 All valves shall be of the quarter-turn type and shall be selected for ease of operation and freedom from leakage.

4.14.5.4 All water system piping shall be tested on the tank-to-pump 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 the system operating pressure.

4.14.6 Overheat Protection. 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 overheat protection system shall be automatic and operate a visual alarm if an overheating situation occurs.

4.14.7 Pressure Relief Valves. A pressure relief system shall be provided to protect and ensure optimum performance of the system.

4.14.8 Drains. A drainage system shall be provided appropriate for the design of the vehicle.

4.15 Water Tank.

4.15.1 Capacity.

4.15.1.1 A water tank shall have a usable capacity as specified in Table 4.1.1(a) and Table 4.1.1(b).

4.15.1.2 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 allow the use of at least 85 percent of the rated capacity with the vehicle positioned as follows:

- (1) On a 20 percent side slope
- (2) On a 30 percent ascending grade
- (3) On a 30 percent descending grade

4.15.2 Construction.

4.15.2.1 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 necessary 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.

4.15.2.2 The tank shall be equipped with easily removable manhole covers over the tank discharge. Tanks shall be designed to allow for internal and external inspection and service. A large capacity drain connection shall be installed at the bottom of the sump.

4.15.2.3 Provisions shall be made for necessary overflow and venting. Venting shall be sized to allow agent discharge at the maximum design flow rate without danger of tank collapse and shall be sized to allow 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.

4.15.2.4 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 shall be easily removable as a unit. Water tanks used as an integral part of unitized rigid body construction shall be permitted.

4.15.2.5 The water tank shall be equipped with at least one top fill opening of not less than 20.3 cm (8 in.) internal diameter. The top fill shall be equipped with an easily removable strainer of 6.4 mm (¼ in.) mesh construction. The top fill opening shall be equipped with a cap designed to prevent spillage.

4.15.2.6 For vehicles less than 1998.5 L (528 gal), the water tank shall be equipped with at least one top fill opening of not less than 127 mm (5 in.) internal diameter.

4.15.3 Tank Fill Connection(s).

4.15.3.1 A tank fill connection(s) shall be provided in a position where it can be reached easily from the ground.

4.15.3.2 All couplings shall be specified by the purchaser to the standard for the airport.

4.15.3.3 The connection(s) shall be provided with strainers of 6.4 mm (¼ in.) mesh and shall have check valves or shall be constructed so that water is not lost from the tank when connection or disconnection is made.

4.15.3.4 The tank fill connection(s) shall be sized to allow filling of the water tank in 2 minutes at a pressure of 551.6 kPa (80 psi) at the tank intake connection.

4.16* Foam System.

4.16.1 Foam-Liquid Concentrate Tank(s).

4.16.1.1 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 two tanks of water at the maximum tolerance specified in NFPA 412.

4.16.1.2 Foam-liquid concentrate tanks shall be permitted to be of either the rigid or flexible type. The tank(s) shall be designed for compatibility with the foam concentrate being used and shall resist all forms of deterioration that could be caused by the foam concentrate or water.

4.16.1.3 Tanks shall be designed to allow for internal and external inspection and service. A large capacity drain connection shall be installed at the bottom of the sump.

4.16.1.4 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 4.16.4 and with the vehicle discharging two tank loads of usable water as specified in 4.15.1.

4.16.1.5 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. Foam-liquid tanks used as an integral part of unitized rigid body construction shall be permitted. 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.

4.16.1.6 A top fill trough shall be provided and shall be equipped with a mesh screen constructed of noncorrosive materials and container openers to allow emptying 18.9 L (5 gal) 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.

4.16.1.7 The tank fill connection(s) shall be provided in a position where it can be reached easily from the ground to allow the pumping of foam-liquid concentrate into the storage tank(s). The connection(s) shall be provided with strainers of 6.4 mm (¼ in.) mesh and shall have check valves or shall be constructed so that foam is not lost from the tank when connection or disconnection is made.

4.16.1.8 Where flexible tanks are used, the supply system shall be designed so that the flexible tanks are not 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.

4.16.1.9 The tank(s) shall be vented adequately to allow rapid and complete filling without the buildup of excessive pressure and to allow emptying of 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.

4.16.2 Foam Proportioning System Flushing. The foam-liquid concentrate system shall be arranged so that the entire piping system can be flushed readily with clear water.

4.16.3 Foam-Liquid Concentrate Piping.

4.16.3.1* The foam-liquid concentrate piping shall be of material resistant to corrosion by foam-liquid concentrates addressed in this standard. 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 it has been demonstrated that the stipulated plasticizer does not adversely affect the performance characteristics of the foam-liquid concentrates addressed in this standard. The plastic pipe shall be permitted to be reinforced with glass fibers.

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

4.16.4 Foam Proportioning Systems.

4.16.4.1 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.

4.16.4.2 The proportioning system shall be sufficiently accurate to provide for the discharge of finished foam within the range specified in NFPA 412.

4.16.4.3 Each nozzle shall have minimum foam discharge patterns, from a dispersed stream of 4.6 m (15 ft) in width and 6.1 m (20 ft) in range to a straight foam stream with a 19.8 m (65 ft) range.

4.17 Premixed Foam Solutions.

4.17.1 Premixed — Pump System. Where premix solution in the main water tank is selected as the means of proportioning



foam to water, the foam solution used shall be aqueous film-forming foam (AFFF) only. Care shall be exercised that the premixed solution is mixed to exact proportions. Where premix solution is used, operation of the vehicle fire-fighting system shall conform to the requirements of Sections 4.14 and 4.15.

4.17.2 Premixed — Pressurized System.

4.17.2.1 Liquid Agent Container(s).

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

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

4.17.2.1.3 An American Society of Mechanical Engineers (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 gauge shall be provided that indicates the internal pressure of the agent storage container at all times.

4.17.2.1.4 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 shall be less than 76.2 mm (3 in.) in diameter. Filling shall be accomplished without the removal of any of the extinguisher piping or any major component.

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

4.17.2.2 Propellant Gas.

4.17.2.2.1 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 to purge all piping and hose lines after use.

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

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

4.17.2.2.4 A pressure gauge shall be provided and shall indicate the pressure of the propellant gas source at all times.

4.17.2.2.5 Cylinder valves, gauges, and piping shall be arranged to preclude accidental mechanical damage.

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

4.17.2.3 Pressure Regulation.

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

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

4.17.2.3.3 Pressure-regulating devices shall be equipped with a spring-loaded relief valve that relieves any excess pressure that develops in the regulator.

4.17.2.3.4 The pressure regulator shall be permitted to be of a type without pressure indicating gauges.

4.17.2.4 Piping and Valves.

4.17.2.4.1 All propellant piping and fittings shall conform to the appropriate ASME document and shall be designed to withstand the working pressure of the system. The design of the piping and valving shall provide the desired flow of gas into the system and the minimum amount of restriction from the liquid agent container(s) to the hose connection. Where more than one hose line is provided, piping and fittings shall be sized and designed so that there is equal flow to each line, regardless of the number of lines placed in operation.

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

4.17.2.4.3 Drains shall be provided to allow complete draining of the system. Drains shall be easily accessible and shall not require the removal of panels, doors, or components for access.

4.17.2.4.4 All valves shall be of the quarter-turn, quick-opening ball type. A maximum of two operations, exclusive of the nozzle, shall be provided to charge the system. Controls shall be arranged for simultaneous charging of the liquid agent and dry chemical systems. Valves on the gas cylinder specified in 4.17.2.2.2 shall not be required to be of the quarter-turn, quick-opening ball type.

4.17.2.4.5 A quick-acting control to be operated by the driver to pressurize the liquid agent system from the cab of the vehicle shall be provided, with a similar control at the unit.

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

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

4.18 Turret Nozzles.

4.18.1 Aircraft rescue and fire-fighting vehicles shall have one or two primary turret nozzles.

4.18.2 Turret nozzles with liquid flow rates of 2839 L/min (750 gpm) or more shall be of the dual discharge type and arranged to allow selection of either 50 percent or 100 percent of the turret capacity. The primary turret discharge rates shall have a tolerance of +10 percent/-0 percent.

4.18.3 If a turret nozzle is visible from the operator's position in all ranges of motion, an elevation and azimuth indication shall not be required.

4.18.4 The purchaser shall specify whether a manually operated or a power-assisted turret shall be provided. Where a manually operated turret is specified, controls shall be in the cab, operation force shall be less than 133.4 N (30 lbf), and an indication of turret elevation and azimuth shall be provided. Where a power-assisted turret is specified, controls shall be in the cab, operation force shall be less than 133.4 N (30 lbf), an indicator of turret elevation and azimuth shall be provided, and, where specified, a manual override, or secondary parallel

controls powered by an alternate source of all roof turret movement functions shall be provided in the cab. The secondary, parallel controls shall be capable of operating the turret with a failed primary control system. The manual override operation force shall be less than 133.4 N (30 lbf). Where turret control is at the platform, operation forces shall be less than 222.4 N (50 lbf).

4.18.5 Turrets shall be capable of being elevated at least 45 degrees above the horizontal and shall be depressed to discharge agent within 9.1 m (30 ft) in front of the vehicle at full output using a dispersed stream. Where a single turret is used on a vehicle, it shall be capable of being rotated not less than 90 degrees to either side, with total traverse not less than 180 degrees. Where two turrets are used on a vehicle, suitable stops shall be provided so that neither turret can interfere with the other turret. Turret controls for both foam and dry chemical turrets shall be accessible both to the driver and the crew member.

4.18.6* If the primary turret is of the extendable type, it shall meet the following design and functional requirements:

- (1) The primary turret shall comply with Chapter 20 of NFPA 1901 and shall meet the requirements of 4.2.1.3 and 4.2.1.4 of this standard while in the stowed position. The vehicle shall achieve a 20 percent side slope, with the extendable turret fully elevated and the nozzle rotated uphill at maximum horizontal rotation while discharging at maximum flow rate. The vehicle shall be provided with an interlock or warning system and placards in full view of the driver/operator to provide the operational limitations during all phases of operation. Flow rates shall be in accordance with Table 4.1.1(c) and Table 4.1.1(d) for major vehicles.
- (2) The primary turret shall meet the primary water-foam agent turret discharge requirements of Table 4.1.1(c) and Table 4.1.1(d) for the applicable vehicle class while in the bedded position.
- (3) The primary turret shall meet the foam quality standard of NFPA 412 for the applicable foam applicator and foam type.
- (4) The primary turret shall function during ARFF operations without the need for outriggers or other ground contact stabilizers that would render the vehicle immobile or hinder its maneuverability.
- (5) The primary turret shall achieve the elevation and reach needed to service the highest engine for the type of aircraft being protected and shall start application within 30 seconds of activation of the deployment cycle. The high rise, telescoping, and/or articulating movement of the boom/tower shall be accomplished with not more than two adjacent lever controls and shall be permitted to be manual or automated for pre-selected positioning of the elevation and reach. If automated, these functions shall be provided with a manual override positioning capability.
- (6) The primary turret shall be capable of applying agent to any interior area of the most current wide-body jet, so as not to impede evacuation and for safety considerations of the vehicle operator. In addition, the device shall be capable of positioning the nozzle within 0.6 m (2 ft) of ground level in front of the vehicle and be capable of applying agent to the interior of the aircraft through cargo bay door openings, passenger doorways, and emergency exits on the type of aircraft being protected while the aircraft is in either the gear-up or gear-down landing position.
- (7) The primary turret shall have a range of motion so as to permit positioning of the nozzle to direct a fire-fighting agent stream at least 90 degrees to the longitudinal axis of the fuselage for interior fire extinguishment.
- (8) The turret/boom mechanism shall be capable of providing for horizontal movement along the aircraft of at least 30 degrees left and right of the vehicle centerline so as not to require repositioning or movement of the ARFF vehicle. This horizontal rotation must be accomplished without the deployment of stabilizers or outriggers that might cause a delay in positioning or emergency movement of the rescue vehicle.
- (9) The primary turret shall have sufficient backup systems to allow for override of the single lever boom control and hydraulic system (or other power source) if the primary system becomes disabled.

4.18.6.1 If specified by the purchaser as the primary water-foam and dry chemical turret — that is, to function as a dual agent turret system — the device shall also be capable of meeting the agent discharge performance of Table 4.1.1(c) and Table 4.1.1(d) while in the bedded position.

4.18.6.2 An adjustable or dual flow rate nozzle shall be provided that will allow flow rates and patterns suitable for interior aircraft fire fighting [see Table 4.1.1(c) and Table 4.1.1(d)].

4.18.6.3 Controls for the extendable turret and options shall be as specified. Where specified, the extendable turret shall be fitted with accessories and devices needed for a driver or another operator to remotely perform the interior aircraft and highest engine fire-fighting functions.

4.18.6.4 Where auxiliary agent lines are specified, they shall be capable of discharging either dry chemical or halo-carbon agent or approved equivalent through an appropriate nozzle while the device is extended out and up to its maximum operational reach. Auxiliary agent lines shall meet the minimum auxiliary agent flow rate and pattern requirements of Table 4.1.1(c) and Table 4.1.1(d).

4.18.6.5 Where remote color optics are specified, they shall be capable of sufficient resolution to permit overall fire scene surveillance when fully extended and to provide the driver/operator with the detail needed for placement of the penetration device on the aircraft hull for proper piercing. The camera and associated lighting shall be designed and installed for exterior environmental operating conditions normally encountered by ARFF vehicles. A monitor 178 mm (7 in.) or larger shall be cab-mounted in a roadworthy manner and shall be readily accessible to the driver/operator.

4.18.6.6 Where a skin penetrator/agent applicator is specified, it shall be movable in conjunction with the water-foam nozzle to allow proper placement of the nozzle control. Where a skin penetrator/agent applicator is specified, it shall be capable of the minimum water-foam flow rate and pattern requirements of Table 4.1.1(c) and Table 4.1.1(d).

4.18.6.7* The penetrating nozzle shall be capable of a minimum flow rate of 946 L/min (250 gpm). The nozzle system shall be constructed to direct or spray agent and water on both sides of the aircraft at the same time after the penetration is made. [Concept-delivery shall be multiple holes causing a spray to cover 7.6 m to 9.1 m (25 ft to 30 ft) on each side of the aircraft interior and in the aircraft aisleway.] From a bedded position, penetration and agent discharge shall take place 20 seconds after positioning the vehicle at the aircraft fuselage



and providing water to the floor and ceiling levels beyond the overhead storage bin area.

4.18.7* Lightweight boom-mounted turrets shall be permitted as primary turrets. These turrets shall meet the following design and functional requirements:

- (1) They shall comply with Chapter 20 of NFPA 1901 and shall meet the requirements of 4.2.1.3 and 4.2.1.4 of this standard while in the stowed position.
- (2) They shall achieve a 20 percent side slope with the boom turret fully elevated and the nozzle fully rotated uphill at maximum horizontal rotation while discharging at maximum flow rate.
- (3) Flow rates shall be in accordance with Table 4.1.1(c) and Table 4.1.1(d) for major vehicles.
- (4) They shall meet the primary water-foam agent turret discharge requirements of Table 4.1.1(c) and Table 4.1.1(d) for the applicable vehicle class while in the bedded condition.
- (5) They shall meet the foam quality standard of NFPA 412.
- (6) They shall function during ARE operations without the need for outriggers or other ground contact stabilizers that could render the vehicle immobile or hinder its maneuverability.
- (7) They shall achieve the elevation and reach needed to service the highest engine for the type of aircraft being protected and start application of agent within 30 seconds of activation of the deployment cycle.
- (8) They shall be capable of applying agent through passenger doorways, to interior areas of the type of aircraft being protected. In addition, the device must permit the operator to position the nozzle assembly so as to be able to discharge the agent in front of the vehicle at a level that permits the operator to see over the turret discharge.
- (9) They shall have a range of motion so as to permit positioning of the nozzle to direct a fire-fighting agent stream along the longitudinal axis of the fuselage or up to 90 degrees to the longitudinal axis for interior fire extinguishments.

4.19 Preconnected Handlines. Preconnected handlines shall be those handlines for discharging water or foam, or both, that are specified by the purchaser as intended for use as primary ARFF equipment. All other handlines that are installed on the vehicle shall not be considered as being preconnected handlines.

4.19.1 Combined agent vehicles shall have at least one preconnected handline and nozzle for each agent. Handlines and nozzles shall be permitted to be separate or twinned together for simultaneous agent discharge. Handlines shall be permitted to be reeled handlines as specified in Table 4.1.1(a), Table 4.1.1(b), Table 4.1.1(c), and Table 4.1.1(d).

4.19.2 Each preconnected handline compartment shall be located so that the distance between the handline nozzle and the ground, step, or surface upon which the operator stands to initiate the pulling of the handline from the reel or top layer of collapsible hose is not more than 1.8 m (6 ft) above the surface.

4.19.3 Preconnected Reeled Handlines and Nozzles.

4.19.3.1 Handlines for reels shall have a minimum burst rating three times the nominal working pressure of the system and shall be able to discharge the flow required in Table 4.1.1(c) and Table 4.1.1(d) without unreeling the hose.

4.19.3.2 Each handline shall be equipped with a pistol grip shutoff-type nozzle designed to discharge both foam and water

in accordance with the performance criteria in Table 4.1.1(c) and Table 4.1.1(d) and shall meet the requirements of NFPA 1964.

4.19.3.3 Each hose reel shall be designed and positioned to allow hose reel removal by a single person from any position in a 120 degree horizontal sector. Each hose reel shall be designed to prevent the hose from unreeling when not desired. A power rewind with manual override shall be provided. The nozzle holder, friction brake, rewind controls, and manual valve control shall be accessible to the person using the hose reel.

4.19.3.4 The discharge control to each handline shall be adjacent to the handline and accessible to the person using the handline.

4.19.4 Preconnected Collapsible Handlines and Nozzles.

4.19.4.1 Collapsible handlines shall meet the requirements of NFPA 1961 and Table 4.1.1(c) and Table 4.1.1(d).

4.19.4.2 Each handline shall be equipped with a pistol grip shutoff-type nozzle designed to discharge foam and water in accordance with the performance criteria in Table 4.1.1(c) and Table 4.1.1(d) and shall meet the requirements of NFPA 1964.

4.19.4.3 Hose storage areas shall be fabricated from noncorrosive material and shall be designed to drain effectively. The storage area shall be smooth and free from all projections that might damage the hose. No other equipment shall be mounted or located where it can obstruct the removal of the hose.

4.19.4.4 The discharge control to each handline shall be adjacent to the handline and accessible to the person using the handline.

4.20 Turret, Ground Sweep, and Undertruck Nozzles.

4.20.1 Where a bumper turret or ground sweep nozzle(s) is provided, the controls shall be mounted inside the cab within easy reach of the driver and a crew position. Where the extendable, or boom, turret is capable of supplying agent as specified as a primary turret, as a bumper turret, or as a ground sweep nozzle(s), the requirement for a bumper turret or ground sweep nozzle(s) shall be permitted to be omitted at the option of the purchaser.

4.20.2 The turret shall have a horizontal rotation of 180 degrees and vertical travel of +45 degrees/-20 degrees.

4.20.3 Where specified, 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.

4.20.4 Turrets, handlines, and ground sweeps shall discharge foam having the quality specified in NFPA 412. Measurement of the expansion ratio and 25 percent drainage times shall be in accordance with the procedures outlined in NFPA 412.

4.21 Complementary Agent System. Where specified, the vehicle shall be equipped with a complementary agent system.

4.21.1 Dry Chemical Container. The dry chemical container shall be constructed in accordance with the ASME *Boiler and Pressure Vessel Code*, Section 8, or equivalent, and shall be so stamped.

4.21.1.1 All piping and fittings shall conform to the appropriate ASME, or equivalent, code and shall be designed to withstand the

working pressure of the system. The design of the piping and valving shall provide the desired flow of gas into the system and the minimum amount of restriction from the chemical container(s) to the hose connection. Where more than one hose line is provided, piping and fittings shall be sized and designed so that there is equal flow to each line, regardless of the number of lines placed in operation.

4.21.1.2 Provisions shall be made for purging all piping and hose of dry chemical after use without discharging the dry chemical remaining in the dry chemical container(s). Provisions also shall be made for the depressurization of the dry chemical container(s) without the loss of the remainder of the dry chemical. A pressure gauge shall be provided that indicates the internal pressure of the agent storage container(s) at all times.

4.21.1.3 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(s) to fluidize the contents, such design also shall include a manual operating feature.

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

4.21.1.5 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.

4.21.1.6* The fill opening in the dry chemical container shall be located so that it is easily accessible for recharging and necessitates a minimum amount of time and effort to open and close. Filling shall be accomplished without the removal of any of the extinguisher piping or any major component.

4.21.1.7 A quick-acting control to be operated by the driver to pressurize the dry chemical agent system from the cab of the vehicle shall be provided, with a similar control at the handline.

4.21.1.8 The pressure container shall be designed to allow hydrostatic testing.

4.21.2 Dry Chemical Propellant.

4.21.2.1 The propelling agent shall be dry nitrogen, dry air, argon, or carbon dioxide.

4.21.2.2 All propellant gas cylinders and valves shall be in accordance with U.S. DOT, or equivalent, requirements or regulations. Cylinders shall bear the DOT marking or equivalent markings.

4.21.2.3 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 allow the complete purging of all piping and hose lines after each use.

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

4.21.2.5 A pressure gauge shall be provided and shall indicate the pressure on the propellant gas source at all times.

4.21.2.6 Cylinder valves, gauges, and piping shall be arranged to preclude accidental mechanical damage.

4.21.3 Dry Chemical Pressure Regulation.

4.21.3.1 Pressure regulation shall be designed to reduce the normal cylinder pressure automatically and to hold the pro-

pellant gas pressure at the designed operating pressure of the dry chemical container(s).

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

4.21.3.3 Pressure-regulating devices shall be equipped with a spring-loaded relief valve that relieves any excess pressure that develops in the regulator.

4.21.3.4 The pressure regulator shall be permitted to be of a type without pressure indicating gauges.

4.22 Halogenated Agent.

4.22.1 Halogenated Agent Container.

4.22.1.1 The storage container shall be designed for pressurization and shall be constructed in accordance with the ASME *Boiler and Pressure Vessel Code*, or equivalent, and shall be so marked.

4.22.1.1.1 Where specified, a re-service kit shall be provided with the delivery of the truck.

4.22.1.2 The material of construction shall be resistant to corrosion by the halogenated agent to be stored.

4.22.1.3 A readily accessible charge coupling of sufficient size to allow ease in filling shall be provided. Filling shall be accomplished without the removal of any of the extinguisher piping or any major component. A pressure gauge shall be provided that indicates the internal pressure of the agent storage containers at all times.

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

4.22.2 Halogenated Agent Propellant Gases.

4.22.2.1 The propellant gas shall be provided in sufficient quantity to expel the halogenated agent as well as to purge all piping and hose lines after use.

4.22.2.1.1 Dry air shall have a dew point of -51°C (-60°F) or lower.

4.22.2.1.2 Dry nitrogen shall have a dew point of -51°C (-60°F) or lower.

4.22.2.2 All propellant gas cylinders and valves shall be in accordance with U.S. DOT, or equivalent, requirements or regulations. Cylinders shall bear the DOT marking or equivalent markings.

4.22.2.3 Pipes and valves connected to the halogenated agent container shall conform to the appropriate ASME, or equivalent, code and shall be designed to withstand the working pressure of the system.

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

4.22.2.5 A pressure gauge shall be provided and shall indicate the pressure of the propellant gas source at all times.

4.22.2.6 Cylinder valves, gauges, and piping shall be arranged to preclude accidental mechanical damage.

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

