NFPA®

414

Standard for Aircraft Rescue and Fire-Fighting Vehicles

2017

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ISBN: 978-145591401-2 (Print)
ISBN: 978-145591402-9 (PDF)

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NFPA® 414

Standard for

Aircraft Rescue and Fire-Fighting Vehicles

2017 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. It was issued by the Standards Council on May 13, 2016, with an effective date of June 2, 2016, and supersedes all previous editions.

This edition of NFPA 414 was approved as an American National Standard on June 2, 2016.

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 concisely provided many requirements that previously were covered by numerous paragraphs.

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

For the 2012 edition of NFPA 414, the committee went through the entire document and made a multitude of changes to the requirements. Those changes included the addition of an equivalency statement, to provide the AHJ or purchaser some flexibility when it comes to meeting the requirements. There was also a new emphasis placed on Chapter 5, which deals with aircraft interior access vehicles. This was due largely to the increase in need for these vehicles based on the increased size of aircraft as well as some limitations to traditional aircraft rescue and fire-fighting (ARFF) vehicles, whose primary function is fire fighting. These vehicles assist in the evacuation of passengers from aircraft in addition to the use of evacuation slides or if the slides are not appropriate for use and deployment. Another important item addressed in the 2012 edition was that many ARFF vehicles are operated by a single person and that many of the devices and warnings/alarms are now designed with a single user/operator in mind. Generally speaking, many of the changes or enhancements that were introduced into the 2012edition revolved around the development and use of larger aircraft, such as the A-380 and the Boeing Dreamliner, as well as the composite materials from which they are manufactured. The capacities for ARFF vehicles have to be increased to address this change in aircraft as well as to ensure that the vehicles are still able to meet prescribed response time standards. The committee has also addressed the environmental impact some extinguishing agents pose and have either limited them or removed them from the document and replaced them with acceptable alternatives. The committee also reviewed the entire document to ensure that it is consistent with the source documents, with commonly accepted practices as they relate to the ARFF industry, and with the *Manual of Style for NFPA Technical Committee Documents.*

The 2017 edition revisions include updates to referenced publications and definitions and a rewrite of Chapter 5, Aircraft Interior Access Vehicles. This rewrite includes the addition of language to address cab visibility, cab construction, equipment, AIAV body, docking platform, acceptance criteria, and testing. Revisions also include extracted language from NFPA 1901 on SCBA mounting and a full extract of NFPA 1901 language for Chapter 6, Electrical System Performance Tests.

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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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2017 Edition

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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.

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 E. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. 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 E.

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.

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 Equivalency.

1.3.1 Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.3.2 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.3.3 The system, method, or device employed shall be demonstrated to meet the acceptance criteria for the intended purpose to the authority having jurisdiction.

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,* 2014 edition.
NFPA 1901, *Standard for Automotive Fire Apparatus,* 2016 edition.
NFPA 1961, *Standard on Fire Hose,* 2013 edition.
NFPA 1964, *Standard for Spray Nozzles,* 2013 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. ASME Technical Publishing Office, Two Park Avenue, New York, NY 10016-5990.

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 D4956, *Standard Specification for Retroreflective Sheeting for Traffic Control,* 1994.

2.3.4 Federal Aviation Administration Publications. Available from Department of Transportation, Distribution Unit, M-494.3, Washington, DC 20590.

FAA Advisory Circular No. 150/5210-19A - *Driver's Enhanced Vision System (DEVS).*

2.3.5 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.

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

SAE J156, *Fusible Links*, 1997.

SAE J551/1, *Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles, Boats (up to 15 m), and Machines (16.6 Hz to 18 GHz),* 2010.

SAE J553, *Circuit Breakers*, 1996.

SAE J554, *Electric Fuses (Cartridge Type)*, 1987.

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

SAE J1127, *Low Voltage Battery Cable*, 1995.

SAE J1128, *Low Voltage Primary Cable*, 1995.

SAE J1888, *High Current Time Lag Electric Fuses*, 1990.

SAE J1908, *Electrical Grounding Practice*, 1996.

SAE J2077, *Miniature Blade Type Electrical Fuses*, 1990.

SAE J2174, *Heavy-Duty Wiring Systems for Trailers 2032 mm or More in Width*, 2009.

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

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

SAE J2202, *Heavy-Duty Wiring Systems for On-Highway Trucks*, 2003.

SAE J2418, *Occupant Restraint System Evaluation — Frontal Impact Component-Level Heavy Trucks*, 2003.

SAE J2420, *COE Frontal Strength Evaluation—Dynamic Loading Heavy Trucks*, 2010.

SAE J2422, *Cab Roof Strength Evaluation—Quasi-Static Loading Heavy Trucks*, 2010.

2.3.7 UNECE Publications. UN Economic Commission for Europe, Palais des Nations, CH-1211, Geneva 10 Switzerland.

ECE Regulation number 29, *Uniform Provisions Concerning the Approval of Vehicles with Regard to the Protection of the Occupants of the Cab of a Commercial Vehicle*, 2007.

2.3.8 U.S. Government Publications. U.S. Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Federal Motor Carrier Safety Administration: *FMVSS 121 Brake Performance and Stability Testing.*

2.3.9 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 402, *Guide for Aircraft Rescue and Fire-Fighting Operations,* 2013 edition.
NFPA 1901, *Standard for Automotive Fire Apparatus,* 2016 edition.

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.

3.2.6 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Aggressive Tire Tread. See 3.3.61.1.

3.3.2* Aircraft Rescue and Fire Fighting (ARFF). The fire-fighting action taken to prevent, control, or extinguish fire involved or adjacent to an aircraft for the purpose of maintaining maximum escape routes for occupants using normal and emergency routes for egress. [**402,** 2013]

3.3.3 Air-Mechanical Brakes. See 3.3.13.1.

3.3.4 Air-Over-Hydraulic Brakes. See 3.3.13.2.

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 ARFF Chassis. The assembled frame, engine, drivetrain, and tires of an ARFF vehicle.

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

3.3.11 Axle Tread. See 3.3.61.2.

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

3.3.13 Brakes.

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

3.3.13.2 ***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.

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

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

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

3.3.16 Component Manufacturer's Certification. A signed application approval furnished by the vehicle manufacturer certifying that the components are approved as being installed in the vehicle for their intended use, or that the components comply with the criteria required by the standard.

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

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

3.3.19 Differential Global Positioning System (DGPS). See 3.3.59.3.1.

3.3.20 Driver's Enhanced Vision System (DEVS). See 3.3.59.1.

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

3.3.22 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.

3.3.23 Extendable Turret. See 3.3.62.1.

3.3.24 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.

3.3.25 Foam Concentrate. A concentrated liquid foaming agent as received from the manufacturer.

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

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

3.3.28* 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.

3.3.29 Fully Loaded Vehicle. See 3.3.69.1.

3.3.30 Global Positioning System (GPS). See 3.3.59.3.

3.3.31 Ground Sweep Nozzle. See 3.3.40.1.

3.3.32 Halogenated Agents. A liquefied gas extinguishing agent that extinguishes fire by chemically interrupting the combustion reaction between fuel and oxygen.

3.3.33 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.

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

3.3.35* 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.

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

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

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

3.3.39 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.

3.3.40 Nozzle.

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

3.3.40.2 ***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.

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

3.3.42 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.

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

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

3.3.45 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.

3.3.46 Primary Turret. See 3.3.62.2.

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

3.3.48 Prototype Vehicle. See 3.3.69.2.

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

3.3.50 Ramp Angle. See 3.3.35, Interaxle Clearance Angle (Ramp Angle).

3.3.51 Readily Accessible. Able to be located, reached, serviced, or removed without removing other components or parts of the apparatus and without the need to use special tools to open enclosures. [**1901,** 2016]

3.3.52 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.

3.3.53* 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.

3.3.54 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.

3.3.55 Service Brake. See 3.3.13.3.

3.3.56 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.

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

3.3.58 Surfaces.

3.3.58.1 ***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.

3.3.58.2 ***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.

3.3.59 System.

3.3.59.1* ***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.

3.3.59.2* ***Electronic Stability Control System.*** A closed-loop stability-control system that relies on proven antilock brake system and traction control system components.

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

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

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

3.3.61 Tread.

3.3.61.1 ***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.

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

3.3.62 Turret.

3.3.62.1* ***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.

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

3.3.63* 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.

3.3.64 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.

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

3.3.66 Undertruck Nozzle. See 3.3.40.2.

3.3.67 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.

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

3.3.69 Vehicle.

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

3.3.69.2* ***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.

3.3.70* 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.

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

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

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

3.3.74 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 range from −40°C to 0°C (−40°F to 32°F) or lower, some type of winterization system shall 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 Requirements for All Aircraft Rescue and Fire-Fighting Vehicles — Responsibility of Contractors/Suppliers.

4.2.1* 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.

4.2.2 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 4.2.2.1 through 4.2.2.3.9.

4.2.2.1 Operator's Manual.

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

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

4.2.2.1.3 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

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

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

4.2.2.2.2 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.

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

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

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

4.2.2.2.6 The service manual shall contain a suitable index.

4.2.2.3 Parts Manual.

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

4.2.2.3.2 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.

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

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

	Minimum Usable Capacity		
Performance Parameters	**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)	25	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

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

4.2.2.3.5 The parts identification manual shall contain a numerical index.

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

4.2.2.3.7 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.

4.2.2.3.8 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.

4.2.2.3.9 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.

4.2.2.3.10* Parts manuals shall not be required for commercial chassis vehicles supplied to a component manufacturer. Parts manuals shall be required for upfit components added to the commercial chassis.

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

	Minimum Usable Capacity		
Performance Parameters	**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)	25	30	30
Angle of departure (degrees)	30	30	30
Interaxle clearance (degrees)	9	12	12
Underbody clearance (in.)	13	18	18
Underaxle clearance at differential housing bowl (in.)	8.5	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

4.2.3 Metal Finish.

4.2.3.1 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.

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

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

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

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

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

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

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

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 and must follow roof turret flows and ranges	Can be used as the primary turret and must follow roof turret flows and ranges	Can be used as the primary turret and must follow roof turret flows and ranges
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

(continues)

Table 4.1.1(c) ***Continued***

	Minimum Usable Capacity		
Performance Parameters	**Vehicle Water Tank Capacity ≥454 to ≤1999 L**	**Vehicle Water Tank Capacity >1999 to ≤6000 L**	**Vehicle Water Tank Capacity >6000 L**
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
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

(continues)

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**
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

4.2.3.6 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.

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

4.2.3.8 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.

4.2.4 Lettering, Numbering, and Striping.

4.2.4.1 Vehicle numbering, lettering, and minimum 0.2 m (8 in.) wide reflective striping shall be provided in accordance with ASTM D4956.

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

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

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

4.2.4.3.2 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.

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

4.2.5 Vehicle Information Data Plate. A data plate that contains, as a minimum, all the information presented in Figure 4.2.5 shall be installed in the cab of the vehicle.

4.3 Weights and Dimensions.

4.3.1* Weights.

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

4.3.1.2* The weight shall be distributed over the axles and tires of the fully loaded vehicle.

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

4.3.1.2.2 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. This requirement shall not apply to vehicles with a capacity of <1999 L (528 gal).

4.3.1.2.3 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.

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

4.3.1.3 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.

4.3.1.4 If a commercial chassis is utilized, the chassis manufacturer's recommended center of gravity shall not be exceeded.

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

4.3.1.6 The vehicle shall not exhibit oversteer characteristics. *(See 6.3.2.3 for test requirements.)*

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

	Minimum Usable Capacity		
Performance Parameters	**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	≥60	≥750	≥1250
Individual flow rate of the roof turret, if used in combination with a bumper turret (gpm)	N/A	≥500	≥1000
b. Stream pattern/distances:			
i. Straight/far point (ft)	≥65	≥190	≥230
ii. Dispersed/far point (ft)	≥20	≥65	≥70
iii. Dispersed/width (ft)	≥15	≥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 and must follow roof turret flows and ranges	Can be used as the primary turret and must follow roof turret flows and ranges	Can be used as the primary turret and must follow roof turret flows and ranges
a. Flow rate (gpm)	≥60	≥250	≥250
b. Straight stream distance (ft)	≥65	≥150	≥150
c. Dispersed pattern distances:			
i. Far point (ft)	≥20	≥50	≥50
ii. Width (ft)	≥15	≥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

(continues)

Table 4.1.1(d) *Continued*

	Minimum Usable Capacity		
Performance Parameters	**Vehicle Water Tank Capacity ≥120 to ≤528 gal**	**Vehicle Water Tank Capacity >528 to ≤1585 gal**	**Vehicle Water Tank Capacity >1585 gal**
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
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 (>7)	≥16 and ≤22	≥16 and ≤22
b. Range (ft)	≥100	≥100	≥100
c. Width (ft)	≥17	≥17	≥17

(continues)

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**
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

4.3.2 Dimensions.

4.3.2.1* 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.

4.3.2.1.1 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.

4.3.2.1.2 Where an active suspension provides vehicle leveling and maintenance of the underbody clearance of the lower underaxle, clearances shown in the parentheses in Table 4.1.1(a) and Table 4.1.1(b) shall be used.

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

4.3.2.2 Field of Vision.

4.3.2.2.1 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 capable of the following::

(1) To see the ground 6.1 m (20 ft) ahead of the vehicle
(2) To have a field of vision of at least 5 degrees above the horizontal plane
(3) To have a field of vision in the horizontal plane of at least 90 degrees on each side from the straight ahead position
(4) Not to have his or her vision obstructed by more than 7 degrees per obstruction

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

4.3.2.3.1 Each side shall be provided with a minimum 45.2 cm^2 (7 $in.^2$) wide-angle (convex) mirror.

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

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

4.3.2.3.3 Convex mirrors shall not be required to be motorized.

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

4.4 Engine.

4.4.1 Performance Requirements.

4.4.1.1 Engine Characteristics.

4.4.1.1.1 The vehicle engine(s) shall have the horsepower, torque, and speed characteristics to meet and maintain all vehicular performance characteristics specified in this standard.

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

4.4.1.2* 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).

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

4.4.1.2.2 The acceleration times provided in Table 4.1.1(a) and Table 4.1.1(b) shall be achieved with the engine(s) and transmission(s) at the component manufacturers' recommended 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.

4.4.1.2.3 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.

4.4.1.3 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).

4.4.2 Engine Cooling Systems.

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

4.4.2.2 This device shall be fitted with an automatic thermostat.

4.4.2.3 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.

4.4.2.3.1 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.

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

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

4.4.3 Fuel System.

4.4.3.1 A complete fuel system shall be installed with the engine manufacturer's approval.

4.4.3.2 The fuel system shall be protected from the following:

(1) Damage
(2) Exhaust heat
(3) Exposure to ground fires
(4) Vapor lock

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

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

4.4.3.3.2 The fuel-water separator shall meet the engine manufacturer's requirements.

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

4.4.3.5 Fuel Capacity.

4.4.3.5.1 For vehicles with a water tank capacity <1999 L (<528 gal), the fuel tank shall have the 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.

4.4.3.5.2 For vehicles with a water tank capacity <1999 L(<528 gal), 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.

4.4.4 Exhaust System.

4.4.4.1 The exhaust system shall be constructed in such a manner that exhaust discharge is directed away from any operators.

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

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

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

4.4.4.3 The tailpipe shall not be directed toward the ground.

4.5 Vehicle Electrical System.

4.5.1 Electrical Systems and Warning Devices.

4.5.1.1 Any low-voltage electrical systems or warning devices installed on the fire apparatus shall be appropriate for the mounting location and intended electrical load and shall meet the specific requirements of this section. [**1901:**13.1]

4.5.1.1.1 Wiring. All electrical circuit feeder wiring supplied and installed by the fire apparatus manufacturer shall meet the requirements of 4.4.1.1.2 through 4.5.1.1.23. [**1901:**13.2]

4.5.1.1.2 The circuit feeder wire shall be stranded copper or copper alloy conductors of a gauge rated to carry 125 percent of the maximum current for which the circuit is protected. [**1901:**13.2.1]

4.5.1.1.3 Voltage drops in all wiring from the power source to the using device shall not exceed 10 percent. [**1901:**13.2.1.1]

4.5.1.1.4 The use of star washers for circuit ground connections shall not be permitted. [**1901:**13.2.1.2]

4.5.1.1.5 All circuits shall otherwise be wired in conformance with SAE J2202, *Heavy-Duty Wiring Systems for On-Highway Trucks*, or for trailer wiring, SAE J2174, *Heavy-Duty Wiring Systems for Trailers 2032 mm or More in Width.* [**1901:**13.2.1.3]

4.5.1.1.6 Wiring and Wire Harness Construction. [**1901:**13.2.2]

4.5.1.1.7 All insulated wire and cable shall conform to SAE J1127, *Low-Voltage Battery Cable*, or SAE J1128, *Low-Voltage Primary Cable*, type SXL, GXL, or TXL. [**1901:**13.2.2.1]

4.5.1.1.8 All conductors shall be constructed in accordance with SAE J1127 or SAE J1128, except where good engineering practice dictates special strand construction. [**1901:**13.2.2.1.1]

4.5.1.1.9 Conductor materials and stranding, other than copper, shall be permitted if all applicable requirements for physical, electrical, and environmental conditions are met as dictated by the end application. [**1901:**13.2.2.1.2]

4.5.1.1.10 Physical and dimensional values of conductor insulation shall be in conformance with the requirements of SAE J1127 or SAE J1128, except where good engineering practice dictates special conductor insulation. [**1901:**13.2.2.1.3]

4.5.1.1.11 The overall covering of conductors shall be moisture-resistant loom or braid that has a minimum continuous rating of 90°C (194°F) except where good engineering practice dictates special consideration for loom installations exposed to higher temperatures. [**1901:**13.2.2.2]

4.5.1.1.12 The overall covering of jacketed cables shall be moisture resistant and have a minimum continuous temperature rating of 90°C (194°F), except where good engineering practice dictates special consideration for cable installations exposed to higher temperatures. [**1901:**13.2.3]

4.5.1.1.13 All wiring connections and terminations shall use a method that provides a positive mechanical and electrical connection. [**1901:**13.2.4]

4.5.1.1.14 The wiring connections and terminations shall be installed in accordance with the device manufacturer's instructions. [**1901:**13.2.4.1]

4.5.1.1.15 All ungrounded electrical terminals shall have protective covers, enclosures, or a means to protect from accidental shorting. [**1901:**13.2.4.2]

4.5.1.1.16 Wire nut, insulation displacement, and insulation piercing connections shall not be used. [**1901:**13.2.4.3]

4.5.1.1.17 Wiring shall be restrained to prevent damage caused by chafing or ice buildup and protected against heat, liquid contaminants, or other environmental factors. [**1901:**13.2.5]

4.5.1.1.18 Wiring shall be uniquely identified at least every 2 ft (0.6 m) by color coding or permanent marking with a circuit function code. The identification shall reference a wiring diagram. *[See NFPA 1901.]* [**1901:**13.2.6]

4.5.1.1.19 Circuits shall be provided with properly rated low-voltage overcurrent protective devices. [**1901:**13.2.7]

4.5.1.1.20 Such devices shall be readily accessible and protected against heat in excess of the overcurrent device's design range, mechanical damage, and water spray. [**1901:**13.2.7.1]

4.5.1.1.21 Circuit protection shall be accomplished by utilizing fuses, circuit breakers, fusible links, or solid state equivalent devices. [**1901:**13.2.7.2]

4.5.1.1.22 If a mechanical-type device is used, it shall conform to one of the following SAE standards:

(1) SAE J156, *Fusible Links*
(2) SAE J553, *Circuit Breakers*
(3) SAE J554, *Electric Fuses (Cartridge Type)*
(4) SAE J1888, *High Current Time Lag Electric Fuses*
(5) SAE J2077, *Miniature Blade Type Electrical Fuses*

[**1901:**13.2.7.3]

4.5.1.1.23 Switches, relays, terminals, and connectors shall have a direct current (dc) rating of 125 percent of maximum current for which the circuit is protected. [**1901:**13.2.8]

4.5.1.2 Line Voltage Electrical Systems. The line voltage electrical systems shall be in accordance with Chapter 22 of NFPA 1901.

4.5.2 Battery Chargers.

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

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

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

4.5.4 Where specified, an onboard battery charger/conditioner shall have a minimum output rating of 0.5 percent of the cold-cranking ampere rating at 0°C (32°F) of the engine-starting battery system.

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

4.5.4.2 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.

4.5.4.3 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.

4.5.4.4 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.

4.5.4.5 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.

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

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

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

4.5.6 Radio suppression of the electrical system shall be in accordance with SAE J551/1 or an equivalent radio suppression standard.

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

4.6.1 The entire drivetrain shall be designed and rated by the component manufacturer as having the strength to slip the wheels of the static-loaded vehicle on a surface having a coefficient of friction of 0.8.

4.6.2 The transmission shall be approved by its manufacturer for the application.

4.6.3 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.

4.6.4 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.

4.6.4.1 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.

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

4.6.5 All-Wheel Drive.

4.6.5.1 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.

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

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

4.6.6.1 This requirement shall not apply to vehicles with a capacity of <1999 L (<528 gal).

4.6.7 Axle Capacity.

4.6.7.1 Front and rear axles shall have the gross axle weight rating (GAWR) capacity to carry the maximum imposed load under all intended operating conditions.

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

4.7* 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

4.8 Rims, Tires, and Wheels.

4.8.1 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.

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

4.8.3* Only new tires shall be mounted on the vehicles.

4.8.4 All wheels on vehicles of more than 1999 L (528 gal) capacity shall be of the single-wheel type, with all rims, tires, and wheels of an identical size and the same tire tread design.

4.8.5 Rims, tires, and wheels shall be certified by their respective manufacturers as having the capacity to meet the specified performance.

4.8.6 Tires shall be certified by their respective manufacturers for not less than 42.9 km (25 mi) of continuous operation at 96.5 kph (60 mph) when inflated at the operational pressure.

4.9* 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.

4.10 Brakes.

4.10.1* The braking system shall comply with FMVSS 121:

(1) No part of the brake chamber shall project below the axle bowls.
(2) The air system shall have the capacity for quick buildup from 0 kPa (0 psi) to release of spring brakes within 15 seconds.

4.10.2* 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.

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

4.10.2.2 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).

4.10.2.3 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).

4.10.2.4 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.

4.10.2.5 For each vehicle, the service brakes shall provide one power-assisted stop while the vehicle engine is inoperative for the stopping distances specified in 4.10.2.2 through 4.10.2.4.

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

4.10.4 Brakes — Air System.

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

4.10.4.2 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.

4.10.4.3 Visual and audible low–air pressure warning devices that are visible and audible to the driver from inside the cab of the vehicle shall be provided.

4.11 Steering.

4.11.1 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.

4.11.2 The power steering system shall have the capacity so that no more than 66.7 N (15 lbf) pull is needed on the steering wheel rim 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.

4.11.3* The wall-to-wall turning diameter of the fully loaded vehicle shall be less than three times the vehicle length.

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

4.12.1 Cab Interior.

4.12.1.1 The cab shall be fully enclosed (i.e., floor, roof, and four sides).

4.12.1.2 Seating for the crew shall be restricted to the cab.

4.12.1.3 The maximum number of crew seat positions provided in the cab designated by the manufacturer shall be labeled in the cab.

4.12.1.4 As a minimum, seat positions shall be provided, for the driver and for an additional crew member.

4.12.1.5 Three-point seat belts equipped with a single hand hookup shall be provided for each of the designated seating positions.

4.12.1.6 Space shall be provided for all instrument controls and equipment specified without hindering the crew.

4.12.1.7 Doors shall be provided on each side of the cab with steps and handrails to allow rapid entrance and exit from the cab while wearing full protective equipment.

4.12.1.8 Each door shall be equipped with a restraint device(s) to prevent the door from being sprung open by wind or jet blast.

4.12.2 Cab Visibility.

4.12.2.1 The cab shall meet the visibility requirements of 4.3.2.2.

4.12.2.2 Interior cab reflections from exterior and interior lighting shall be minimized.

4.12.2.3 The windshield shall be shatterproof safety glass.

4.12.2.4 All other windows shall be constructed of safety glass.

4.12.2.5 Where equipped with a primary turret having manual controls above the cab roof, the cab roof shall be designed with a quick access to the primary turret(s).

4.12.3 Cab Construction.

4.12.3.1 The cab shall be weatherproof.

4.12.3.2 The cab shall be fully insulated thermally and acoustically with a fire-resistant material.

4.12.3.3 The cab interior noise level at any seated position shall not exceed 85 dBA while the vehicle is being driven at 80.5 kph (50 mph) on a level, hard surface without warning devices operating.

4.12.3.4 While stationary and discharging water or foam from the high-volume turrets with exterior warning devices operating, the maximum noise level inside the cab shall be 90 dBA.

4.12.3.5 The cab shall be permitted to be of the unitized rigid body and frame structure type or a separate unit that is flexibly mounted on the main vehicle frame.

4.12.3.6* Cabs on apparatus with a GVWR greater than 11,800 kg (26,000 lb) shall meet the requirements of one of the following sets of standards:

(1) SAE J2420, *COE Frontal Strength Evaluation —— Dynamic Loading Heavy Trucks,* and SAE J2422, *Cab Roof Strength Evaluation —— Quasi-Static Loading Heavy Trucks*
(2) ECE Regulation number 29, *Uniform Provisions Concerning the Approval of Vehicles with Regard to the Protection of the Occupants of the Cab of a Commercial Vehicle*

[**1901:**14.3.2]

4.12.4 Instruments, Warning Lights, and Controls.

4.12.4.1 The minimum number of instruments, warning lights, and controls consistent with the operation of the vehicle, chassis, and fire-fighting system shall be provided.

4.12.4.1.1 All chassis instruments and warning lights shall be grouped on a panel in front of the driver.

4.12.4.1.2 All fire-fighting system instruments, warning lights, and controls shall be grouped by function to provide ready accessibility and high visibility for the driver as well as crew members.

4.12.4.2* All instruments and controls shall be illuminated.

4.12.4.3 Groupings of both the chassis and the fire-fighting system instruments, warning lights, and controls shall be easily removable as a unit or shall be accessible for servicing.

4.12.4.4 The following instruments and warning lights 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 or tank level
(9) Low–air pressure warning
(10) Headlight beam indicator
(11) Engine(s) oil pressure
(12) Voltmeter(s)
(13) Transmission oil temperature
(14) Forward-looking infrared (FLIR) monitor

4.12.4.4.1 The components in 4.12.4.4(4), 4.12.4.4(6), 4.12.4.4(7), 4.12.4.4(8), and 4.12.4.4(9) shall not be applicable to a small commercial chassis.

4.12.4.5 The cab shall have all the following controls within reach of the driver for operation of the vehicle and the pumping system:

(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

4.12.4.6* Where specified, a windshield deluge system shall be designed to flood the windshield with clear water and to be energized automatically whenever the system is operated.

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

4.12.4.7.1 The DEVS system shall meet or exceed the following requirements as outlined in FAA Advisory Circular AC No. 150/5210-19A:

(1) Chapter 1, Section 2, Subsection b, Part (2) Navigation
(2) Chapter 2, Full Sections 5–7, 16–19, 21
(3) Chapter 2, Full Sections 16–19

4.12.4.7.2 Where specified, the DEVS navigation system as described in 4.12.4.7.1 shall include a tracking and onboard information system that meets or exceeds the following requirements as outlined in FAA Advisory Circular No. 150/5210-19A:

(1) Chapter 1, Section 2, Subsection b, Part (3) Tracking
(2)* Chapter 2, All

4.12.4.8* A low-visibility enhanced vision system shall be installed in the vehicle consisting of an FLIR system that meets or exceeds the following requirements as outlined in FAA Advisory Circular No. 150/5210-19A:

(1) Chapter 1, Section 2, Subsection b, Part (1) Vision Enhancement
(2) Chapter 2, Full Sections 6, 7, 10, 11, and 12

4.12.5 Equipment.

4.12.5.1 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; the vertical adjustment shall not apply to commercial vehicles with a capacity of <1999 L (528 gal).]
(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) A means or provision that is designed to protect driver and crew from overhead glare and light from the sun
(9) Outside rearview mirrors, as specified in 4.3.2.3
(10) Interior lighting
(11) Provisions for mounting at each crew seat position self-contained breathing apparatus (SCBA) of the type specified by the purchaser
(12) Low-visibility FLIR meeting suggested specifications contained in Section D.4 or equivalent

4.12.5.2* SCBA Mounting. Where SCBA holders are mounted within a driving or crew compartment, they shall comply with the following:

(1) The SCBA holder shall retain a pack and bottle combination for the published weight rating of the holder when subjected to the dynamic force pulse per SAE J2418, *Occupant Restraint System Evaluation — Frontal Impact Component-Level Heavy Trucks*.
(2) If the SCBA unit is mounted in a seatback, the release mechanism shall be accessible to the user while seated.
(3) Brackets that lock automatically either in the event of impact or when the parking brake is released, but are not locked at other times, shall be permitted.
(4)* The SCBA holder shall retain the bottle when subjected to the deceleration pulse at 0, 30, 90, and 180 degrees with respect to the direction of bottle extraction and in the horizontal plane.
(5) The SCBA holder shall retain the bottle when subjected to a deceleration pulse that exceeds 2 g for at least 60 ms in the vertical direction.
(6) The deceleration pulse shall meet the SAE J2418 deceleration profile with an accuracy of ±10 percent within the 35 to 95 ms range.

(7) The deceleration pulse shall be measured on a rigid portion of the base of the test fixture.
(8) The test component shall be retained in the holder during and after the dynamic test.
(9) The force required to extract the bottle after each test shall be no more than 125 percent of the initial extraction force.
(10) The SCBA holder shall be attached to the fixture in the same manner that it will be fastened to the seat or vehicle.
(11) The test bottle shall not move more than 3 in. relative to the frame of the holder during each test.
(12) The test fixture shall not allow the holder frame to move more than 3 in. relative to the base of the test sled.
(13) Each holder shall bear a label affixed by the holder manufacturer certifying compliance to these specifications.

[**1901:**14.1.9.1]

4.12.5.3 Equipment Mounting.

4.12.5.3.1 All equipment required to be used during an emergency response shall be securely fastened. [**1901:**14.1.10.1]

4.12.5.3.2 All equipment not required to be used during an emergency response, with the exception of SCBA units, shall not be mounted in a driving or crew area unless it is contained in a fully enclosed and latched compartment capable of containing the contents when a 9 g force is applied in the longitudinal axis of the vehicle or a 3 g force is applied in any other direction, or the equipment is mounted in a bracket(s) that can contain the equipment when the equipment is subjected to those same forces. [**1901:**14.1.10.2]

4.12.6 Signs visible from each seated position that state "Occupants must be seated and wearing a seat belt when apparatus is in motion" shall be provided.

4.12.7* 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

4.12.7.1 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.

4.12.7.2 The data acquisition 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.

4.12.8* If a lateral acceleration indicator is provided, it shall be adjustable for sensitivity and provide both visual and audio warning signals and warnings to the driver.

4.13 Body.

4.13.1 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 exposure to excess heat, and body panels shall be removable where necessary to provide access to the interior of the vehicle.

4.13.2 Access doors shall be provided for those areas of the interior of the vehicle that are inspected frequently, including, but not limited to, the following:

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

4.13.3 Compartments for storage of equipment and tools to be carried on the vehicle shall have the following characteristics:

(1) Be weather resistant
(2) Be self-draining
(3) Be lighted

4.13.4 A working deck that is reinforced and constructed of, or covered with, a slip-resistant material 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.

4.13.5 Handrails or bulwarks shall be provided where necessary for the safety and convenience of the crew.

4.13.5.1 Access handrails or handholds shall be provided at each entrance to a driving or crew compartment and at each position where steps or ladders for climbing are located. [**1901:**15.8.1]

4.13.5.2 Exterior access handrails shall be constructed of or covered with a slip-resistant, noncorrosive material. [**1901:**15.8.2]

4.13.5.3 Exterior access handrails shall be between 25.4 mm and 41.275 mm (1 in. and 1 5⁄8 in.).

4.13.6 Steps or ladders shall be provided for access to the top fill area.

4.13.6.1 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.

4.13.6.2 All other steps shall be rigidly constructed and constructed of, or covered with, a slip-resistant material.

4.13.6.3 The lowermost step(s) shall be no more than 558.8 mm (22 in.) above level ground when the vehicle is fully loaded.

4.13.6.4 Lighting shall be provided to illuminate steps and walkways.

4.13.7 A front bumper shall be mounted on the vehicle and secured to the frame structure.

4.13.8 Vehicle numbering, lettering, and minimum 20.3 cm (8 in.) wide reflective striping shall be provided in accordance with ASTM D4956.

4.13.8.1 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 4.13.8.

4.13.8.2 Striping shall be placed on at least 60 percent of the perimeter length of each side, width, and rear.

4.13.8.3 At least 40 percent of the perimeter width of the front of the vehicle shall have reflective striping.

4.13.9 Attachments shall be provided for all tools, equipment, and other items that the purchaser specifies to be furnished on the vehicle.

4.13.9.1 Equipment holders shall be attached and designed so that equipment remains in place under all operating conditions.

4.13.9.2 The equipment holders shall allow the equipment to be readily accessible and removable for use.

4.13.10* Each storage compartment identified by the vehicle manufacturer for use by the purchaser shall be labeled with tested weight.

4.13.11 Compartment loading shall not be exceeded as identified at the time of vehicle manufacture.

4.13.12 Provisions shall be made for mounting tools and equipment, as specified by the purchaser, on the truck.

4.13.13 Special tools for servicing the vehicle, fire suppression system, and any of the auxiliary equipment shall be identified specifically by the vehicle manufacturer and furnished as necessary by the vehicle manufacturer.

4.14 Fire-Fighting Systems and Agents.

4.14.1 For ARFF purposes, vehicles using primary extinguishing agents shall be tested in accordance with all requirements of NFPA 412.

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

4.14.3* All components of the agent systems shall be made of materials resistant to corrosion by the primary agent, primary agent/water solution, water, and, where specified, the complementary agent.

4.14.4 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.

4.15 Agent Pump(s) and Pump Drive.

4.15.1 Agent Pump(s).

4.15.1.1 The water pump(s) shall be constructed of corrosion-resistant metals of the single-stage or multiple-stage centrifugal type agreed upon by the end user and manufacturer, and designed for emergency service.

4.15.1.1.1 Pumps shall be gravity primed from the vehicle tank.

4.15.1.1.2 The pump and piping system shall be designed to eliminate the entrapment of air.

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

4.15.1.3 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.

4.15.2 Pump Drive.

4.15.2.1 The pump(s) drive shall allow operation of the pump(s) and simultaneous operation of the vehicle.

4.15.2.1.1 The pump(s) shall not be affected by changes in transmission ratios or the actuation of clutches in the vehicle drive.

4.15.2.1.2 The design of the drive system and controls shall prevent damage to the drive and minimize lurching of the vehicle when the vehicle drive is engaged during pumping operations.

4.15.2.1.3 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.

4.15.2.1.4 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.

4.15.2.2 While pumping at rated capacity, the drive shall allow controlled vehicle operation at speeds from 0 kph to a maximum of 16.1 kph (0 mph to a maximum of 10 mph) in forward direction and 0 kph to a maximum of 8 kph (0 mph to a maximum of 5 mph) in rearward direction.

4.15.2.2.1 During shifting from forward to rearward drive, the pumping system shall maintain the preset discharge pressure.

4.15.2.2.2 The pump(s) drive shall have the power capacity to provide the pump(s) discharge requirements of 4.15.1.3 while the vehicle is being propelled under all operating conditions where fire-fighting capability is needed.

4.15.2.3 If an independent engine is used to drive the pump(s), it shall operate with the same fuel and electrical system as the chassis engine

4.15.3 Tank-to-Pump Connections.

4.15.3.1 The tank-to-pump system shall be designed for flow at the pumping rates required by 4.15.1.3.

4.15.3.2 A drain shall be at the lowest point with a valve for draining all the liquid from the pumping system.

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

4.15.5 Piping, Couplings, and Valves.

4.15.5.1 Union or rubber-gasketed fittings shall be provided where necessary to facilitate removal of piping.

4.15.5.2 Piping shall be provided with flexible couplings to minimize stress.

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

4.15.5.4 The tank-to-pump side of the pump piping shall be leak free.

4.15.5.5 All water and foam solution discharge piping, together with the agent pump(s), shall be tested at 50 percent above the system operating pressure.

4.15.6 Overheat Protection. An automatic system with a visual alarm shall be provided to prevent overheating of the pumps while they are engaged and operating at zero discharge.

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

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

4.16 Water Tank.

4.16.1 Capacity.

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

4.16.1.2 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.

4.16.1.3 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

4.16.2 Construction.

4.16.2.1 The tank shall be constructed to resist all forms of deterioration that could be caused by the water and the foam concentrate while affording the structural integrity necessary for off-road operation.

4.16.2.2 The tank shall have the following characteristics:

(1) Be equipped with removable manhole covers over the tank discharge
(2) Be designed to allow for internal and external inspection and service
(3) Have longitudinal and transverse baffles
(4) Have a minimum 63.5 mm (2½ in.) capacity drain connection installed at the bottom of the sump

4.16.2.3 Provisions shall be made for necessary overflow and venting.

4.16.2.3.1 Venting shall be sized to allow agent discharge at the maximum design flow rate without danger of tank collapse.

4.16.2.3.2 Vents shall be sized to allow rapid and complete filling without exceeding the internal pressure design limit of the tank.

4.16.2.3.3 Overflows shall be designed to prevent loss of water from the tank during maneuvering and to direct the discharge of overflow water directly to the ground.

4.16.2.3.4 Water tank shall be full at start of tilt-table test.

4.16.2.3.5 Water loss shall be prevented during tilt-table testing.

4.16.2.4 The water tank shall have the following characteristics:

(1) Be mounted in a manner that limits the transfer of the torsional strains from the chassis frame to the tank during off-pavement driving
(2) Be separate and distinct from the crew compartment, engine compartment, and chassis
(3) Be able to be removed as a unit
(4) Be permitted to be an integral part of unitized rigid body construction

4.16.2.5 The water tank shall be equipped with at least one top fill opening of not less than 20.3 cm (8 in.) internal diameter.

4.16.2.5.1 The water tank top fill shall be equipped with an easily removable strainer of 6.4 mm (¼ in.) mesh construction.

4.16.2.5.2 The water tank top fill opening shall be equipped with a cap designed to prevent spillage.

4.16.2.6 For vehicles less than 1999 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.

4.16.3 Tank Fill Connection(s).

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

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

4.16.3.3 The connection(s) shall be provided with strainers of 6.4 mm (¼ in.) mesh.

4.16.3.4 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.

4.16.3.5 The tank connections shall have check valves or shall be constructed so that water is not lost from the tank when a connection or disconnection is made.

4.17* Foam System.

4.17.1 Foam-Liquid Concentrate Tank(s).

4.17.1.1 The purchaser shall specify the percent concentrate foam system to be provided and that it have a working capacity sufficient for two tanks of water at the maximum tolerance specified in NFPA 412, Section 5.2.

4.17.1.2 The tank(s) shall be designed for compatibility with the foam concentrate being used.

4.17.1.3 Tanks shall be designed to allow for internal and external inspection and service.

4.17.1.4 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 4.17.4 and with the vehicle discharging two tank loads of usable water as specified in 4.16.1.

4.17.1.5 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.

4.17.1.5.1 The foam-liquid concentrate tank shall be removable as a unit.

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

4.17.1.5.3 A flexible tank shall be structurally supported to resist tearing independently of the fluid levels in either the water or foam tanks.

4.17.1.5.4 The structural support shall not be dependent on the fluid level in either the water tank or the foam tank.

4.17.1.6 A top fill trough shall have the following characteristics:

(1) 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)
(2) Be connected to the foam-liquid storage tank(s) with a fill line designed to introduce foam-liquid concentrate to minimize foaming within the storage tank

4.17.1.7 The tank fill connection(s) shall have the following characteristics:

(1) Be provided in a position where it can be reached, but not exceed 1.5 m (5 ft), from the ground to allow the pumping of foam-liquid concentrate into the storage tank(s)
(2) Be provided with strainers of 6.4 mm (¼ in.) mesh and have check valves or be constructed so that foam is not lost from the tank when a connection or disconnection is made

4.17.1.8 Where flexible tanks are used, the supply system shall have the following characteristics:

(1) Be designed so that the flexible tanks are not subject to excess pressure
(2) Be capable of delivering foam-liquid at a rate at least equal to or greater than the maximum discharge rate of the foam system

4.17.1.9 The tank(s) shall have the following characteristics:

(1) Be vented to allow for filling without the buildup of pressure
(2) Allow emptying of the tank at the maximum design flow rate without danger of collapse
(3) Have the vent outlets directed to the ground to prevent spillage of foam-liquid concentrate on vehicle components

4.17.2 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.

4.17.3 Foam-Liquid Concentrate Piping.

4.17.3.1* The foam-liquid concentrate piping shall be of material resistant to corrosion by foam-liquid concentrates addressed in this standard.

4.17.3.1.1 Care shall be taken that combinations of dissimilar metals that produce galvanic corrosion are not selected or that such dissimilar metals are electrically insulated.

4.17.3.1.2 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.

4.17.3.1.3 The plastic pipe shall be permitted to be reinforced with glass fibers.

4.17.3.2 The foam-liquid concentrate piping shall be sized to allow the maximum required flow rate.

4.17.3.3 The foam-liquid concentrate piping shall be arranged to prevent water from entering the foam tank.

4.17.4 Foam Proportioning Systems.

4.17.4.1 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 used for aircraft fire-fighting operations.

4.17.4.2 The proportioning system shall be accurate to provide for the discharge of finished foam within the range specified in NFPA 412, Chapter 5.

4.17.4.3 Each nozzle shall have minimum foam discharge patterns and meet the discharge parameters described in Table 4.1.1(a).

4.18 Premixed Foam Solutions.

4.18.1 Premixed — Pump System.

4.18.1.1* Where premixed solution in the main water tank is selected as the means of proportioning foam to water, the appropriate foam concentrate shall be used in accordance with the manufacturer specifications.

4.18.1.2 Where premixed solution is used, operation of the vehicle fire-fighting system shall conform to the requirements of Sections 4.15 and 4.16.

4.18.2 Premixed — Pressurized System.

4.18.2.1 Liquid Agent Container(s).

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

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

4.18.2.1.3 An ASME-approved pressure relief valve and pressure gauge that indicates the internal pressure of the agent storage container at all times shall be provided on the container and set to prevent pressures in excess of the maximum allowable working pressure.

4.18.2.1.4 A readily accessible fill opening to allow ease in filling, and stirring if necessary, shall be provided.

4.18.2.1.4.1 The fill opening shall be in compliance with ASME or local codes and in no case be less than 76.2 mm (3 in.) in diameter.

4.18.2.1.4.2 Filling shall be accomplished without the removal of any of the extinguisher piping or any major component.

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

4.18.2.2 Propellant Gas.

4.18.2.2.1 The propellant gas shall be dry nitrogen or dry compressed air.

4.18.2.2.2 All propellant gas cylinders and valves shall be constructed and marked in accordance with U.S. Department of Transportation (DOT) requirements or regulations.

4.18.2.2.3 The design of the propellant source shall provide for replacement after each use.

4.18.2.2.3.1 Design of the propellant system shall provide for replacement of the high-pressure gas cylinder from the ground by a single person.

4.18.2.2.4 A pressure gauge that indicates the pressure of the propellant gas source at all times shall be provided.

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

4.18.2.2.6 The cylinder valve shall be capable of being opened by quick-acting control and permit remote operation.

4.18.2.2.7 The propellant gas supply shall be sized to provide the capability to expel the fire-fighting agent as well as to purge all piping and hose lines after use.

4.18.2.3 Pressure Regulation.

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

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

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

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

4.18.2.4 Piping and Valves.

4.18.2.4.1 All propellant piping and fittings shall have the following characteristics:

(1) Conform to the appropriate ASME document
(2) Be designed to withstand the working pressure of the system

4.18.2.4.1.1 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.

4.18.2.4.1.2 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.

4.18.2.4.2 Provisions shall be made for the following:

(1) Purging of all piping and hose of the liquid after use without discharging the liquid agent remaining in the container(s)
(2) Depressurization of the liquid agent container(s) without the loss of the remainder of the liquid agent

4.18.2.4.3 Readily accessible drains shall be provided to allow complete draining of the system.

4.18.2.4.4 All valves shall be of the quarter-turn, quick-opening ball type.

4.18.2.4.4.1 A maximum of two operations, exclusive of the nozzle, shall be provided to charge the system.

4.18.2.4.4.2 Controls shall be arranged for simultaneous charging of the liquid agent and dry chemical systems.

4.18.2.4.4.3 Valves on the gas cylinder specified in 4.18.2.2.2 shall not be required to be of the quarter-turn, quick-opening ball type.

4.18.2.4.5 Identical quick-acting controls shall be provided to pressurize the liquid agent system from the cab of the vehicle and the unit.

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

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

4.19 Turret Nozzles.

4.19.1 ARFF vehicles shall have at least one primary turret nozzle with a discharge rate tolerance of +10 percent ±0 percent.

4.19.2 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's capacity.

4.19.3 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.

4.19.4 The purchaser shall specify a manually operated or a power-assisted turret.

4.19.4.1 Where a manually operated turret is specified, the following shall apply:

(1) Controls shall be in the cab.
(2) Operation force shall be less than 133.4 N (30 lbf).
(3) An indicator of turret elevation and azimuth shall be provided.

4.19.4.2 Where a power-assisted turret is specified, the following shall apply:

(1) Controls shall be in the cab.
(2) An indicator of roof turret elevation and azimuth shall be provided.
(3) Where specified, a manual override or secondary control powered by an alternative source of all turret movement functions shall be provided.

(4) Where specified, secondary controls shall be capable of operating the turret with a failed primary control system.
(5) Where specified, the manual override for turret operation force shall be less than 133.4 N (30 lbf).

4.19.4.3 Where turret control is at the platform, operation forces shall be less than 222.4 N (50 lbf).

4.19.5 Turrets shall be capable of the following:

(1) Being elevated at least 45 degrees above the horizontal
(2) Discharging agent within 9.1 m (30 ft) in front of the vehicle at full output using a dispersed stream
(3) Where a single turret is used on a vehicle, being rotated not less than 90 degrees to either side, with total traverse not less than 180 degrees
(4) Where two turrets are used on a vehicle, stopping so that neither turret can interfere with the other turret
(5) Providing access to turret controls for both foam and dry chemical turrets to the driver and crew members

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

(1) The primary turret shall meet the requirements of 4.3.1.3 and 4.3.1.5 while in the stowed position.
(2) 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.
(3) 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.
(4) Flow rates shall be in accordance with Table 4.1.1(c) and Table 4.1.1(d) for major vehicles.
(5) 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.
(6) The primary turret shall meet the foam-quality standard of NFPA 412 for the applicable foam applicator and foam type.
(7) 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.
(8) The primary turret shall have a deployment time from the bedded position to the maximum height and start the application of agent within 30 seconds.
(9) The high rise, telescoping, and/or articulating movement of the boom/tower shall be accomplished with not more than two adjacent lever controls and be permitted to be manual or automated for preselected positioning of the elevation and reach.
(10) If automated, these functions shall be provided with a manual override positioning capability.
(11) 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.
(12) 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.
(13) 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.
(14) 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.
(15) This horizontal rotation shall be accomplished without the deployment of stabilizers or outriggers that might cause a delay in positioning or emergency movement of the rescue vehicle.
(16) The primary turret shall have 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.
(17) The driver/operator shall be able to see the boom, as it is rising to its maximum height, from a seated position by means of a camera or direct line of sight.

4.19.6.1 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.

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

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

4.19.6.4 Where auxiliary agent lines are specified, they shall have the following characteristics:

(1) Be capable of discharging either dry chemical, halocarbon agent, or approved equivalent through the nozzle while the device is extended out and up to its maximum operational reach
(2) Meet the minimum auxiliary agent flow rate and pattern requirements of Table 4.1.1(c) and Table 4.1.1(d)

4.19.6.5 Where remote color optics are specified:

(1) They shall be capable of permitting overall fire scene surveillance when fully extended and provide the driver/operator with the detail needed for placement of the penetration device on the aircraft hull for piercing.
(2) The camera and associated lighting shall be designed and installed for exterior environmental operating conditions encountered by ARFF vehicles.
(3) A monitor 178 mm (7 in.) or larger shall be cab mounted and viewable from the driver/operator position.

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

4.19.6.7* The penetrating nozzle shall be capable of a minimum flow rate of 946 L/min (250 gpm).

4.19.6.8 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.

4.19.6.9 Concept of delivery shall be multiple holes causing a spray that covers an area of at least 7.6 m (25 ft) along the length of the fuselage left and right of the penetration point.

4.19.6.10 The point of penetration shall be visible to the driver/operator either by direct line of sight or by remote optics for any piercing position on the aircraft as defined by the manufacturer.

4.19.6.11 The penetrating nozzle shall be capable of piercing the aircraft fuselage over the wing area at angles up to 30 degrees left or right of the vehicle centerline in the event that the interior fire is located in this area.

4.19.6.12 The extendable turret with penetrating nozzle shall have the ability to perform a multi-axis, multifunction boom operation with penetration and agent flowing at the penetration point (above the windows and below the overhead stowage bins) of a single passenger deck aircraft in less than 45 seconds.

4.19.6.13 For devices designed to reach the second level of a multilevel passenger aircraft, the same function at the second level shall be achieved in less than 60 seconds.

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

(1) They shall meet the requirements of 4.3.1.3 and 4.3.1.5 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, Chapter 5.
(6) They shall function during ARFF operations without the need for outriggers or other ground contact stabilizers that could render the vehicle immobile or hinder its maneuverability.
(7) The primary turret shall have a deployment time from the bedded position to maximum height and start the application of agent within 30 seconds.
(8) They shall be capable of applying agent through passenger doorways, to interior areas of the type of aircraft being protected.
(9) The device shall 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.
(10) 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.

4.20 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.

4.20.1 Preconnected handlines shall be those handlines for discharging water, foam, or both that are specified by the purchaser as intended for use as primary ARFF equipment.

4.20.2 Combined agent vehicles shall have at least one preconnected handline and nozzle for each agent.

4.20.2.1 Handlines and nozzles shall be permitted to be separate or twinned together for simultaneous agent discharge.

4.20.2.2 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).

4.20.2.3 All other handlines that are installed on the vehicle shall not be considered to be preconnected handlines.

4.20.3 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.

4.20.4 Preconnected Reeled Handlines and Nozzles.

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

4.20.4.2 Each handline shall have the following characteristics:

(1) 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)
(2) Meet the requirements of NFPA 1964

4.20.4.3 Each hose reel shall have the following characteristics:

(1) Be designed and positioned to allow hose reel removal by a single person from any position in a 120 degree horizontal sector
(2) Be designed to prevent the hose from unreeling when not desired
(3) Have power rewind with manual override

4.20.4.4 The nozzle holder, friction brake, rewind controls, and manual valve control shall be accessible to the person using the hose reel.

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

4.20.5 Preconnected Collapsible Handlines and Nozzles.

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

4.20.5.2 Each collapsible handline shall have the following characteristics:

(1) 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)
(2) Meet the requirements of NFPA 1964

4.20.5.3 Hose storage areas shall have the following characteristics:

(1) Be fabricated from noncorrosive material and designed to drain
(2) Be smooth and free from all projections that might damage the hose
(3) Have no other equipment mounted or located where it can obstruct the removal of the hose

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

4.21 Turret, Ground Sweep, and Undertruck Nozzles.

4.21.1* Where a bumper turret or ground sweep nozzle(s) is provided, the controls shall be mounted inside the cab within reach of the driver and a crew position.

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

4.21.3 Where specified, undertruck nozzles shall be mounted under the truck and controlled from the cab to protect the bottom of the vehicle and the inner sides of the wheels and tires with foam solution discharged in a spray pattern.

4.21.4 Turrets, handlines, and ground sweeps shall discharge foam having the quality specified in NFPA 412.

4.21.5 Measurement of the expansion ratio and 25 percent drainage times shall be in accordance with the procedures outlined in NFPA 412, Chapter 6.

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

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

4.22.1.1 All piping and fittings shall conform to the appropriate ASME, or equivalent, code to withstand the working pressure of the system.

4.22.1.1.1 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.

4.22.1.1.2 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.

4.22.1.2 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).

4.22.1.2.1 Provisions also shall be made for the depressurization of the dry chemical container(s) without the loss of the remainder of the dry chemical.

4.22.1.2.2 A pressure gauge shall be provided that indicates the internal pressure of the agent storage container(s) at all times.

4.22.1.3 The system shall have the following characteristics:

(1) Be designed to ensure fluidization of the dry chemical at the time of operation
(2) Include a manual operating feature where any design includes the movement of the chemical container(s) to fluidize the contents

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

4.22.1.5 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.

4.22.1.6* The fill opening in the dry chemical container shall have the following characteristics:

(1) Be located so that it is easily accessible for recharging and necessitates a minimum amount of time and effort to open and close
(2) Allow for filling to be accomplished without the removal of any of the extinguisher piping or any major component

4.22.1.7 Identical quick-acting controls shall be provided to pressurize the dry chemical agent system from the cab of the vehicle and at the handline.

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

4.22.2 Dry Chemical Propellant.

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

4.22.2.2 All propellant gas cylinders and valves shall be designed, constructed, and marked in accordance with U.S. DOT, or equivalent, requirements or regulations.

4.22.2.3 The propellant gas supply shall be sized to provide the capability to expel the fire-fighting agent, as well as to purge all piping and hose lines after each use.

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 to indicate the pressure on the propellant gas source at all times shall be provided.

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

4.22.3 Dry Chemical Pressure Regulation.

4.22.3.1 Pressure regulation shall be designed to reduce the cylinder pressure automatically and to hold the propellant gas pressure at the designed operating pressure of the dry chemical container(s).

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

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

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

4.23 Halogenated Agent.

4.23.1 Halogenated Agent Container.

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

4.23.1.1.1 Where specified, a reservice kit shall be provided with the delivery of the truck.

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

4.23.1.3 A readily accessible charge coupling for filling shall be provided.

4.23.1.3.1 Filling shall be accomplished without the removal of any of the extinguisher piping or any major component.

4.23.1.3.2 A pressure gauge shall be provided that indicates the internal pressure of the agent storage containers at all times.

4.23.1.4 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.

4.23.2 Halogenated Agent Propellant Gases.

4.23.2.1 Selection of the propellent gases shall follow the recommendations of the fire-fighting agent manufacturer.

4.23.2.2 All propellant gas cylinders and valves shall be designed, constructed, and marked in accordance with U.S. DOT regulations.

4.23.2.3 Pipes and valves connected to the halogenated agent container shall be designed to withstand the working pressure of the system.

4.23.2.4 The propellant gas cylinder(s) shall be provided with the capability to expel fire-fighting agents and to purge all piping and hose lines after use.

4.23.2.5 The propellant cylinder(s) shall be readily accessible for replacement.

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

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

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

4.23.3 Halogenated Agent Pressure Regulation.

4.23.3.1 An ASME-approved, or equivalent, pressure relief valve shall be provided on the container and set to prevent pressures in excess of the maximum allowable working pressure.

4.23.3.2 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 halogenated agent container(s).

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

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

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

4.23.4 Halogenated Agent Delivery Piping and Valves.

4.23.4.1 All piping, couplings, and valves shall be sized for flow with minimal restriction and pressure loss.

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

4.23.4.1.2 Piping shall be mounted and provided with flexible couplings to minimize stress.

4.23.4.2 All valves shall have the following characteristics:

(1) Be of the quarter-turn type
(2) Be selected for ease of operation and freedom from leakage

4.23.4.3 All discharge piping shall be tested at 50 percent above the system operating pressure.

4.23.4.4 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.

4.23.4.5 Provisions shall be made for the following:

(1) Purging all piping and hose of the halogenated agent after use, without discharging the halogenated agent remaining in the container(s)
(2) Venting of the halogenated agent container without loss of the remainder of the liquid agent

4.23.4.6 Identical quick-acting controls shall be provided to pressurize the halogenated agent system from the cab of the vehicle and at the handline.

4.23.4.7* All seals within the halogenated agent system and all seals from other systems that can come in contact with the halogenated agent during discharge shall be of a compatible seal material.

4.24 Dry Chemical Turret.

4.24.1 Auxiliary Agent Discharge. Where specified, a turret shall have an auxiliary agent discharge mounted parallel to the foam solution discharge, or entrained within the foam solution discharge stream and controlled the same way and with the same travel requirements as the turret.

4.24.1.1 The dry chemical turret performance shall be in accordance with Table 4.1.1(c) and Table 4.1.1(d). Where entrained dry chemical discharge is specified for water tank capacity under 1999 L (528 gal), the dry chemical flow rate shown in parentheses in Table 4.1.1(c) and Table 4.1.1(d) shall be used.

4.24.1.2 The dry chemical system shall be designed so that the operator can select to discharge both the primary and the complementary agent systems separately or simultaneously.

4.24.2 Complementary Agent Handlines.

4.24.2.1 Handlines for complementary agents shall have a minimum burst pressure rating three times the nominal working pressure of the system and in accordance with the performance criteria in Table 4.1.1(c) and Table 4.1.1(d).

4.24.2.1.1 The complementary agent handline shall be equipped with a nozzle that allows going from a fully open to a fully closed position in a single, simple movement.

4.24.2.1.2 Nozzle construction shall be of nonferrous metal or stainless steel.

4.24.2.2 Multiple agent handlines and nozzles shall be designed so that each agent can be discharged separately or simultaneously, parallel or entrained.

4.24.2.2.1 The barrels shall be linked together to provide coordinated application by one operator.

4.24.2.2.2 Each reel shall be designed and positioned to allow hose line removal by a single person from any position in a 120 degree horizontal sector.

4.24.2.2.3 Each reel shall be equipped with a friction brake to prevent the hose from unreeling when not desired.

4.24.2.2.4 A power rewind with manual override shall be provided.

4.24.2.2.5 The nozzle holder, friction brake, rewind controls, and manual valve control shall be accessible to the person using the hose reel.

4.24.2.2.6 A backup hand crank shall be provided and stored on the vehicle.

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

4.25 Lighting and Electrical Equipment.

4.25.1* Lighting equipment shall be installed in conformity with local road regulations, where practicable, and shall include the following:

(1) Headlights with upper and lower driving beams. A control switch that is readily accessible to the driver shall be provided for beam selection.
(2) In addition to dual taillights and dual stop lights, a minimum of one additional stop light located high up on the rear of the vehicle.
(3) Self-canceling turn signals, front and rear, with a steering column–mounted control and a visual and audible indicator. A four-way flasher switch shall be provided.
(4) Adequate reflectors and marker and clearance lights furnished to describe the overall length and width of the vehicle.
(5) Engine compartment lights, nonglare type, arranged to illuminate both sides of the engine, with individual switches located in the engine compartment. Service lighting shall be provided for all areas described in 4.13.2(1),4.13.2(2), and 4.13.2(3), as well as for the engine compartment.
(6) Lighting for all top-deck working areas.
(7) At least one backup light and an audible alarm with a minimum of 97 dBA that meet SAE J994 installed in the rear of the body.

4.25.2* A warning siren shall be provided that has a sound output of not less than 95 dBA at 30.5 m (100 ft) when measured directly ahead of the siren and not less than 90 dBA at 30.5 m (100 ft), measured at 45 degrees on either side.

4.25.2.1 The siren shall be mounted to allow maximum forward sound projection but shall be protected from foam dripping from the turret or water splashed up by the tires.

4.25.2.2 The siren unit shall consist of the following functions as a minimum: public address, wail, and yelp.

4.25.2.3 A selector switch shall be mounted within reach of the driver that will allow the operation of the vehicle's horn and the siren from the horn button in the steering wheel.

4.25.3 A horn shall be mounted at the front part of the vehicle, with the control positioned so that it is readily accessible to the driver.

4.25.4 Exterior Emergency Warning Lights.

4.25.4.1 A master switch for all exterior emergency warning lights shall be provided in the cab within easy reach of the driver.

4.25.4.2 Emergency warning light(s) shall be mounted on the top of the vehicle and shall be visible for 360 degrees in a horizontal plane.

4.25.4.2.1 The emergency warning light(s) shall be mounted so as to also be visible from the air.

4.25.4.2.2 The purchaser shall provide the vehicle manufacturer with the color of the light(s) and indicate whether the emergency warning lights be LED flasher type, rotating beacon type, or strobe type.

4.25.4.3 Two alternating flashing emergency warning lights shall be mounted at the rear of the vehicle as far apart as practical.

4.25.4.3.1 These lights shall not be mounted any higher than 1828.8 mm (72 in.) above ground level.

4.25.4.3.2 The purchaser shall provide the vehicle manufacturer with the color of the light and indicate whether the emergency warning lights are to be the LED flasher type, sealed beam type, or strobe type.

4.25.4.4 Two alternating flashing emergency warning lights shall be mounted at the front of the vehicle as far apart as practical.

4.25.4.4.1 These lights shall not be mounted any higher than 1828.8 mm (72 in.) above ground level.

4.25.4.4.2 The purchaser shall provide the vehicle manufacturer with the color of the light and indicate whether the emergency warning lights are to be LED flasher type, sealed beam type, or strobe type.

4.25.4.5 The complete emergency warning light system shall require no more than a combined total of 12 volt 40 amps or equivalent for other voltages.

4.25.5 Radios.

4.25.5.1 Provisions shall be made for mounting radios.

4.25.5.1.1 Operation of the radios shall be from the cab.

4.25.5.1.2 Radios shall be mounted to allow quick servicing or replacement.

4.25.5.2 The purchaser shall specify all necessary radios and frequencies that are to be provided.

4.25.6 Where furnished, air horns, an electric siren(s), and an electronic siren speaker(s) shall be mounted as low and as far forward on the apparatus as practical.

4.25.7 Audible warning equipment shall not be mounted on the roof of the apparatus.

4.26 Application. Where any part of a line voltage electrical system is provided as a fixed installation, the applicable requirements of this chapter shall apply.

Chapter 5 Aircraft Interior Access Vehicle

5.1 General.

5.1.1 The fire-fighting vehicle capabilities contained in this chapter are considered to be the minimum acceptable for performance of AIAVs.

5.1.2 Aircraft interior access vehicles (AIAVs) for ARFF 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 shall meet the minimum design, performance, and acceptance requirements of this chapter.

5.1.3 The features and components that, when assembled, produce an efficient and capable AIAV shall meet the requirements of this chapter.

5.1.4 Unless stated, other requirements identified in Chapters 4 and 6 of this standard shall not apply to this chapter.

5.2 AIAV Vehicle Requirements.

5.2.1 AIAV Cab.

5.2.1.1 The AIAV cab shall provide a minimum seating for two fire fighters.

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

5.2.1.3 The cab shall be fully enclosed (i.e., floor, roof, and four sides).

5.2.1.4 Seating for the crew shall be restricted to the cab.

5.2.1.5 The maximum number of crew seat positions provided in the cab designated by the manufacturer shall be labeled in the cab.

5.2.1.6 As a minimum, seat positions shall be provided, for the driver and for an additional crew member.

5.2.1.7 Three-point seat belts equipped with a single hand hookup shall be provided for each of the designated seating positions.

5.2.1.8 Space shall be provided for all instrument controls and equipment specified without hindering the crew.

5.2.1.9 Doors shall be provided on each side of the cab with steps and handrails to allow rapid entrance and exit from the cab while wearing full protective equipment.

5.2.1.10 Each door shall be equipped with a restraint device(s) to prevent the door from being sprung open by wind or jet blast.

5.2.1.11 Cab Visibility.

5.2.1.11.1 The cab shall meet the visibility requirements of 4.3.2.2.

5.2.1.11.2 Interior cab reflections from exterior and interior lighting shall be minimized.

5.2.1.11.3 The windshield shall be shatterproof safety glass.

5.2.1.11.4 All other windows shall be constructed of safety glass.

5.2.1.11.5 Where equipped with a primary turret having manual controls above the cab roof, the cab roof shall be designed with a quick access to the primary turret(s).

5.2.1.11.6 Resources for docking platform driver/operator visibility shall be provided.

5.2.1.12 Cab Construction.

5.2.1.12.1 The cab shall be weatherproof.

5.2.1.12.2 The cab shall be fully insulated thermally and acoustically with a fire-resistant material.

5.2.1.12.3 The cab interior noise level at any seated position shall not exceed 85 dBA while the vehicle is being driven at 80.5 kph (50 mph) on a level, hard surface without warning devices operating.

5.2.1.12.4 While stationary and discharging water or foam from the high-volume turrets with exterior warning devices operating, the maximum noise level inside the cab shall be 90 dBA.

5.2.1.12.5 The cab shall be permitted to be of the unitized rigid body and frame structure type or a separate unit that is flexibly mounted on the main vehicle frame.

5.2.1.12.6 Cabs on apparatus with a GVWR greater than 11,800 kg (26,000 lb) shall meet the requirements of one of the following sets of standards:

(1) SAE J2420, *COE Frontal Strength Evaluation — Dynamic Loading Heavy Trucks, and SAE J2422, Cab Roof Strength Evaluation — Quasi-Static Loading Heavy Trucks*
(2) ECE Regulation number 29, *Uniform Provisions Concerning the Approval of Vehicles with Regard to the Protection of the Occupants of the Cab of a Commercial Vehicle*

[**1901:**14.3.2]

5.2.2 Equipment. 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; the vertical adjustment shall not apply to commercial vehicles with a capacity of <1999 L (<528 gal).]
(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) A means or provision that is designed to protect driver and crew from overhead glare and light from the sun
(9) Outside rearview mirrors, as specified in 4.3.2.3
(10) Interior lighting
(11) Provisions for mounting at each crew seat position self-contained breathing apparatus (SCBA) of the type specified by the purchaser

5.2.3 SCBA Mounting. Where SCBA holders are mounted within a driving or crew compartment, they shall comply with the following:

(1) The SCBA holder shall retain a pack and bottle combination for the published weight rating of the holder when subjected to the dynamic force pulse per SAE J2418, *Occupant Restraint System Evaluation — Frontal Impact Component-Level Heavy Trucks*.
(2) If the SCBA unit is mounted in a seatback, the release mechanism shall be accessible to the user while seated.
(3) Brackets that lock automatically either in the event of impact or when the parking brake is released, but are not locked at other times, shall be permitted.
(4)* The SCBA holder shall retain the bottle when subjected to the deceleration pulse at 0, 30, 90, and 180 degrees with respect to the direction of bottle extraction and in the horizontal plane.
(5) The SCBA holder shall retain the bottle when subjected to a deceleration pulse that exceeds 2 g for at least 60 ms in the vertical direction.
(6) The deceleration pulse shall meet the SAE J2418 deceleration profile with an accuracy of ±10 percent within the 35 to 95 ms range.
(7) The deceleration pulse shall be measured on a rigid portion of the base of the test fixture.
(8) The test component shall be retained in the holder during and after the dynamic test.
(9) The force required to extract the bottle after each test shall be no more than 125 percent of the initial extraction force.
(10) The SCBA holder shall be attached to the fixture in the same manner that it will be fastened to the seat or vehicle.
(11) The test bottle shall not move more than 3 in. relative to the frame of the holder during each test.
(12) The test fixture shall not allow the holder frame to move more than 3 in. relative to the base of the test sled.
(13) Each holder shall bear a label affixed by the holder manufacturer certifying compliance to these specifications.

[**1901:**14.1.9.1]

5.2.4 Equipment Mounting.

5.2.4.1 All equipment required to be used during an emergency response shall be securely fastened. [**1901:**14.1.10.1]

5.2.4.2 All equipment not required to be used during an emergency response, with the exception of SCBA units, shall not be mounted in a driving or crew area unless it is contained in a fully enclosed and latched compartment capable of containing the contents when a 9 g force is applied in the longitudinal axis of the vehicle or a 3 g force is applied in any other direction, or the equipment is mounted in a bracket(s) that can contain the equipment when the equipment is subjected to those safe forces. [**1901:**14.1.10.2]

5.3 AIAV Body.

5.3.1 Compartments shall be provided to store tools and equipment conforming to manufacturers' load specifications.

5.3.2 Outriggers/stabilizers shall be provided for vehicle stability.

5.4 AIAV Aircraft Access/Egress.

5.4.1* The vehicle shall provide access from ground level to aircraft door sill heights at least to the lower aircraft door sills of the largest aircraft operating at the airport.

5.4.2* The aircraft access system shall not be configured as a ladder.

5.4.3 Access ramps/stairs shall not exceed a vertical angle of 40 degrees.**[SAE AIR6133, 5, Table 4]**

5.4.4 The stepping surface to the docking platform shall have a minimum width of 1.07 m (42 in.).

5.4.5 A handrail shall be provided on each side of the access extending from the docking platform to the bottom of the access, and the height of the handrail measured from the stepping surface shall be a minimum of 0.76 m (30 in.).

5.4.6 Lighting shall be provided to fully illuminate the stepping surfaces at 5 fc (53 lx).

5.4.7 Step strength shall be at least 1221 kg/m^2 (250 lb/ft^2) at any point. **[SAE AIR 6133, 6.1, Table 5]**

5.4.8 Stepping surfaces of access ramps/stairs shall be slip resistant and have the following characteristics:

(1) Be nonskid both wet and dry
(2) Have a coefficient of friction not less than 0.5
(3) Be resistant to the collection of water and snow
(4) Allow water and snow that does collect to be easily removed
(5) Be resistant to the catching of narrow shoe heels on small contact areas
(6) Be resistant to deformation by narrow shoe heels on small contact areas

[SAE AIR 6133, 6.2.1]

5.5 AIAV Docking Platform.

5.5.1* General. The docking platform of the vehicle shall be sized to allow a Type A aircraft door to be fully opened, allowing fire fighters and their equipment access to the aircraft.

5.5.1.1 The vehicle shall have a horizontal gap control of at least 10 degrees to either side of the leading edge of the docking platform.

5.5.1.2 The docking platform floor strength shall be designed to support 140 kg (308 lb) at any point.**[SAE AIR 6133, 6.1, Table 5]**

5.5.1.3 The docking platform and lift system shall be designed for a bearing load of 317 kg/m^2 (65 lb/ft^2).**[SAE AIR 6133, 6.1, Table 5]**

5.5.2* Handrails. Handrails shall be provided as required.

5.5.3 Docking Platform Controls.

5.5.3.1 The vehicle shall have the ability to control the docking platform from inside the vehicle cab and on the docking platform.

5.5.3.2 The vehicle docking platform shall be able to be controlled by one person using either set of controls.

5.5.3.3 The controls shall be designed such that continuous, deliberate pressure on the control is necessary for activation and continuous operation and such that relief of that pressure will cause control to return to neutral position.

5.6 AIAV Performance Requirements.

5.6.1 The access vehicle shall have off-pavement driving capabilities.

5.6.2* The vehicle's clearance circle diameter of the fully loaded vehicle shall be less than three times the maximum overall length of the vehicle.

5.6.3 The vehicle shall pass a 5 degree tilt test with stairs fully extended and loaded to the manufacturer's recommended maximum weight capacity.

5.6.4* From a 1.5 degree horizontal side slope, the vehicle shall have the ability to auto-level the stairs and docking platform to horizontal.

5.7 AIAV Safety Requirements.

5.7.1 Docking Platform.

5.7.1.1 The docking platform shall provide a method to prevent a sudden drop of the docking platform in the event of a vertical lift system failure.

5.7.1.2 The docking platform shall have a device warning the operator that the leading edge of the docking platform is within 152 mm (6 in.) of the aircraft fuselage.

5.7.1.3 The vehicle shall be designed so that the docking platform can be manually lowered and evacuated in the event of power failure.

5.7.1.4 There shall be a method to keep the vehicle from moving with passengers on the stairs or platform.

5.7.1.5 To verify the safety of the requirement in 5.5.1.3, a 317 kg/m^2 (65 lb/ft^2) weight shall be applied to the docking platform for a period of 4 hours, with no platform drift.

5.7.2 Placards and Signs. A placard indicating vehicle traveling height, weight, and speed limitations shall be displayed within sight of the driver.

5.7.3 GVW. 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.

5.7.4 Approvals. Manufacturer's application approvals shall be provided for all major and safety critical components of the chassis.

5.7.5 Wind Stability Requirements. The AIAV shall be stable when exposed to wind blasts up to 75 km/h (40 knots) without cautions and/or restrictions (without outriggers and/or stabilizers) and up to 120 km/h (65 knots) with adequate precautions and/or restrictions (with outriggers and/or stabilizers). **["Reprinted with permission from SAE AIR 1375D Copyright ©2014 SAE International."]**

5.7.6 Lighting and Electrical Equipment.

5.7.6.1 Lighting equipment shall be installed in conformity with local road regulations, where practicable, and shall include the following:

(1) Headlights with upper and lower driving beams shall be provided, along with a control switch for beam selection that is readily accessible to the driver.
(2) Dual taillights and dual stop lights shall be provided, and a minimum of one additional stop light shall be located high up on the rear of the vehicle.
(3) Self-canceling turn signals, front and rear, with a steering column–mounted control and a visual and audible indicator shall be provided, along with a four-way flasher switch.
(4) Adequate reflectors and marker and clearance lights shall be furnished to describe the overall length and width of the vehicle.
(5) Engine compartment lights, nonglare type, shall be provided and arranged to illuminate both sides of the engine, with individual switches located in the engine compartment. Service lighting shall be provided for all areas described in 4.13.2(1), 4.13.2(2), and 4.13.2(3), as well as for the engine compartment.
(6) Lighting for all top-deck working areas shall be provided.
(7) At least one backup light and an audible alarm with a minimum of 97 dBA that meet SAE J994 shall be installed in the rear of the body.

5.7.6.2 A warning siren shall be provided that has a sound output of not less than 95 dBA at 30.5 m (100 ft) when measured directly ahead of the siren and not less than 90 dBA at 30.5 m (100 ft) when measured at 45 degrees on either side.

5.7.6.2.1 The siren shall be mounted to allow maximum forward sound projection but shall be protected from foam dripping from the turret or water splashed up by the tires.

5.7.6.2.2 The siren unit shall consist of the following functions as a minimum: public address, wail, and yelp.

5.7.6.2.3 A selector switch shall be mounted within reach of the driver that will allow the operation of the vehicle's horn and the siren from the horn button in the steering wheel.

5.7.6.3 A horn shall be mounted at the front part of the vehicle, with the control positioned so that it is readily accessible to the driver.

5.7.7 Exterior Emergency Warning Lights.

5.7.7.1 A master switch for all exterior emergency warning lights shall be provided in the cab within easy reach of the driver.

5.7.7.2 Emergency warning light(s) shall be mounted on the top of the vehicle and shall be visible for 360 degrees in a horizontal plane.

5.7.7.2.1 The emergency warning light(s) shall be mounted so as to also be visible from the air.

5.7.7.2.2 The purchaser shall provide the vehicle manufacturer with the color of the light(s) and indicate whether the emergency warning lights be LED flasher type, rotating beacon type, or strobe type.

5.7.7.3 Two alternating flashing emergency warning lights shall be mounted at the rear of the vehicle as far apart as practical.

5.7.7.3.1 These lights shall not be mounted any higher than 1828.8 mm (72 in.) above ground level.

5.7.7.3.2 The purchaser shall provide the vehicle manufacturer with the color of the light and indicate whether the emergency warning lights are to be the LED flasher type, sealed beam type, or strobe type.

5.7.7.4 Two alternating flashing emergency warning lights shall be mounted at the front of the vehicle as far apart as practical.

5.7.7.4.1 These lights shall not be mounted any higher than 1828.8 mm (72 in.) above ground level.

5.7.7.4.2 The purchaser shall provide the vehicle manufacturer with the color of the light and indicate whether the emergency warning lights are to be LED flasher type, sealed beam type, or strobe type.

5.7.7.5 The complete emergency warning light system shall require no more than a combined total of 12 volt 40 amps or equivalent for other voltages.

5.7.8 Radios.

5.7.8.1 Provisions shall be made for mounting radios.

5.7.8.1.1 Operation of the radios shall be from the cab.

5.7.8.1.2 Radios shall be mounted to allow quick servicing or replacement.

5.7.8.2 The purchaser shall specify all necessary radios and frequencies that are to be provided.

5.7.9 Where furnished, air horns, an electric siren(s), and an electronic siren speaker(s) shall be mounted as low and as far forward on the apparatus as practical.

5.7.10 Audible warning equipment shall not be mounted on the roof of the apparatus.

5.7.11 Operator's Manual.

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

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

5.7.11.3 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

5.7.12 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.

5.7.13 Reflective Striping. 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 4.13.8.

5.8 AIAV Acceptance Criteria.

5.8.1* Driver Vision Measurement.

5.8.1.1 Test equipment shall consist of a plumb bob, a tape measure, and a protractor or an inclinometer.

5.8.1.2 The vehicle shall be tested in its fully loaded condition, with tires inflated to their recommended operating pressure.

5.8.1.3 The driver's range of visibility shall be determined as follows:

(1) Adjust the driver's seat to its mid position with respect to height, weight, and fore and aft adjustments.
(2) Place a structure on the seat cushion for locating an eye height of 806.5 mm (31¾ in.) and a position of 304.8 mm (12 in.) forward from the seat back. Place the seat back in a vertical position.
(3) Establish the features that limit the upward and downward line of vision that are located directly in front of the driver's seat.
(4) Measure and record the angle above the horizon at which upward vision is obstructed from the eye height point established in 5.8.1.3(2).
(5) Establish the lowest possible line of vision below the horizon directly in front of the eye height point and project this line forward of the cab until it intersects with the ground. Project this line of vision by using a light beam, or, if the windshield is removed, use a string line. Measure and record the distance from this intersection with the ground and the front face of the bumper at the front of the truck.
(6) Stretch a line from the eye height point laterally across the cab in order to establish and ochroid the 90 degree line of vision to the left and right of the straight ahead position. Note obstructions within these angles.

5.8.1.4 The recorded values for the distance at which the line of vision meets the ground in front of the truck and the angle of vision above the horizon shall equal or exceed the vehicle's specification.

5.8.1.5 Obstacles within the 90 degree horizontal line of vision to the right or left shall not create an obstruction of more than 5 degrees per obstruction.

5.8.2 Radio Suppression.

5.8.2.1 Test equipment shall be in accordance with SAE J551/1 or the equivalent standard being used.

5.8.2.2 The vehicle shall be configured with all standard electrical features mounted and operational.

5.8.2.2.1 During the tests, all vehicle engines shall be operated at idle.

5.8.2.2.2 All vehicle-mounted electrical devices functioning at the crash site shall be turned on with the following stipulations:

(1) All vehicle lighting shall be on.
(2) All heating, defrosting, and air-conditioning systems, or as many systems as possible, shall be on with their respective fans adjusted to the maximum speed setting.
(3) Complementary power-generating devices (where applicable) shall be running.
(4) Intermittent warning devices, such as hazard flashers, warning buzzers, and horns, shall be turned off.

5.8.2.3 The vehicle shall be tested in accordance with SAE J551/1 or the equivalent standard being used.

5.8.2.4 The results of the test shall be evaluated in accordance with SAE J551/1 or the equivalent standard being used.

5.8.3 Service/Emergency Brake Test.

5.8.3.1 Instrumentation shall consist of the following:

(1) Calibrated fifth-wheel-type speed measuring device that is accurate to within ±0.8 kph (±0.5 mph) or ±0.5 percent of the actual vehicle speed
(2) Ground speed readout device controlled by the fifth wheel
(3) Trigger device that detects brake pedal movement
(4) Strip chart recording distance traveled, vehicle speed, and the point at which actuation of the brake system occurs

5.8.3.2 The vehicle shall be tested in its fully loaded condition with the brakes adjusted and the tires inflated to the vehicle manufacturer's specifications.

5.8.3.2.1 The brakes shall have been burnished to ensure repeatable results.

5.8.3.3 The service and emergency brake stopping distances shall be determined in the following manner:

(1) While traveling down the center of the lane established by the width of the vehicle plus 1.2 m (4 ft), attain a speed slightly above the desired test speed and release the throttle.
(2) With the strip chart recorder running, at the instant that the vehicle reaches the desired test speed, actuate the brake pedal as if in a panic stop and continue applying the brakes until the vehicle comes to a complete stop. While stopping, modulate the brake pedal as necessary to maintain vehicle control. Record the distance traveled from the time that the brake pedal is applied to the time that the vehicle comes to rest.
(3) Observe whether or not the vehicle leaves the established lane during the brake stop.
(4) Repeat 5.8.3.3(1) through 5.8.3.3(3) for a total of five stops from each test speed.
(5) Repeat 5.8.3.3(1) through 5.8.3.3(4) to obtain results at speeds of 32.2 kph (20 mph) and 64.4 kph (40 mph).
(6) Disable the front service brakes and repeat 5.8.3.3(1) through 5.8.3.3(4) at a test speed of 64.4 kph (40 mph).
(7) Reconnect the front service brakes and disable the rear service brakes and repeat 5.8.3.3(1) through 5.8.3.3(4) at a test speed of 64.4 kph (40 mph).

5.8.3.3.1 Items 5.8.3.3(6) and 5.8.3.3(7) shall not be applicable to commercial chassis.

5.8.3.4 Each of the recorded stops shall be within the specified distance without any part of the vehicle leaving the established test lane.

5.8.4 Service/Park Brake Grade Holding Test.

5.8.4.1 Test equipment shall consist of the following:

(1) Load cell accurate to within ±227 kg (±500 lb) (applicable only to the alternate drawbar method)
(2) Variable load dynamometer sled (applicable only to the alternate drawbar method)

5.8.4.2 The vehicle shall be tested in its fully loaded condition with the brakes adjusted and the tires inflated to the vehicle manufacturer's specifications.

5.8.4.3 The brakes shall have been burnished to ensure repeatable results.

5.8.4.4 The capability of the vehicle's parking brake to hold the vehicle stationary on a 20 percent grade shall be demonstrated either on an actual grade or by means of an equivalent drawbar pull test. If an actual 20 percent grade is available, the tests shall be conducted as follows:

(1) Drive the vehicle in a forward direction onto the 20 percent grade, stop, and set the parking brake.
(2) Shift the transmission to neutral, and release the service brakes and verify that there is no wheel rotation.
(3) Repeat 5.8.4.4(1) and 5.8.4.4(2) with the vehicle facing the opposite direction.

5.8.4.5 If an actual 20 percent grade is not available, the tests shall be conducted as follows:

(1) Drive the vehicle onto the level test pad. Shift the transmission to neutral.
(2) Couple the vehicle to the horizontal force device so that forward drawbar force can be generated. Release the parking brake.
(3) Pull the vehicle forward at a speed of at least 1.6 kph (1 mph). As the vehicle is being pulled, apply the parking brake until a 20 percent equivalent drawbar is generated. A 20 percent equivalent drawbar load is determined as follows:
    (a) A 20 percent grade — 11.31 degree angle
    (b) The loaded vehicle weight × sin 11.31 degrees (0.196), which equals the necessary drawbar pull to simulate holding on a 20 percent grade
    (c) The area of the load cell, determined at the time of the test
    (d) The load cell reading, in kPa (psi), that simulates a 20 percent grade, calculated by the following:

[5.8.4.5]

$$\text{load cell reading} = \frac{\sin 11.31 \text{ degrees} \times \text{vehicle weight}}{\text{area of load cell}}$$

5.8.4.6 The capability of the vehicle's service brake to hold the vehicle stationary on a 50 percent grade shall be demonstrated either on an actual grade or by means of an equivalent drawbar pull test. If an actual 50 percent grade is available, the tests shall be conducted as follows:

(1) Drive the vehicle in a forward direction onto the 50 percent grade, apply the service brakes, and shift the transmission to neutral.
(2) Verify there is no wheel rotation.
(3) Repeat 5.8.4.6(1) and 5.8.4.6(2) with the vehicle facing the opposite direction.

5.8.4.7 If an actual 50 percent grade is not available, the tests shall be conducted as follows:

(1) Drive the vehicle onto the level test pad. Shift the transmission to neutral.
(2) Couple the vehicle to the horizontal force device so that forward drawbar force can be generated. Release the parking brake.
(3) Pull the vehicle forward at a speed of at least 1.6 kph (1 mph). As the vehicle is being pulled, apply the service brakes until a 50 percent equivalent drawbar is generated. A 50 percent equivalent drawbar load is determined as follows:
    (a) A 50 percent grade — 26.57 degree angle
    (b) The loaded vehicle weight × sin 26.57 degrees (0.447), which equals the necessary drawbar pull to simulate holding on a 50 percent grade
    (c) The area of the load cell, determined at the time of the test
    (d) The load cell reading, in kPa (psi), that simulates a 50 percent grade, calculated by the following:

[5.8.4.7]

$$\text{load cell reading} = \frac{\text{sin 26.57 degrees} \times \text{vehicle weight}}{\text{area of load cell}}$$

(4) Repeat 5.8.4.7(1) through 5.8.4.7(3) with a drawbar force applied in the rearward direction.

5.8.4.8 The capability of the vehicle's service brake to hold the vehicle stationary on a 20 percent grade shall be demonstrated either on an actual grade or by means of an equivalent drawbar pull test. If an actual 20 percent grade is available, the tests shall be conducted as follows:

(1) Drive the vehicle in a forward direction onto the 20 percent grade, apply the service brakes, and shift the transmission to neutral.
(2) Verify that there is no wheel rotation.
(3) Repeat 5.8.4.8(1) and 5.8.4.8(2) with the vehicle facing the opposite direction.

5.8.4.9 If an actual 20 percent grade is not available, the tests shall be conducted as follows:

(1) Drive the vehicle onto the level test pad. Shift the transmission to neutral.
(2) Couple the vehicle to the horizontal force device so that forward drawbar force can be generated. Release the parking brake.
(3) Pull the vehicle forward at a speed of at least 1.6 kph (1 mph). As the vehicle is being pulled, apply the service brakes until a 20 percent equivalent drawbar is generated. A 20 percent equivalent drawbar load is determined as follows:
    (a) A 20 percent grade — 11.31 degree angle
    (b) The loaded vehicle weight × sin 11.31 degrees (0.196), which equals the necessary drawbar pull to simulate holding on a 20 percent grade
    (c) The area of the load cell, determined at the time of the test
    (d) The load cell reading, in kPa (psi), that simulates a 20 percent grade, calculated by the following:

[5.8.4.9]

$$\text{load cell reading} = \frac{\text{sin 11.31 degrees} \times \text{vehicle weight}}{\text{area of load cell}}$$

(4) Repeat 5.8.4.9(1) through 5.8.4.9(3) with a drawbar force applied in the rearward direction.

5.8.4.10 The brakes shall lock the wheels and hold the vehicle stationary on both the 20 percent and 50 percent grade (or the brakes shall generate an equivalent drawbar pull), with the vehicle pointed either uphill or downhill.

5.8.5 Steering Control Test. Vehicle's steering system shall be fully operational, with the steering linkage stops adjusted within the manufacturer's specified production tolerance limits.

5.8.5.1 Test equipment shall consist of a steering wheel and a torque meter or a spring scale.

5.8.5.2 The vehicle shall be tested in a fully loaded condition with tires inflated to their operating pressure.

5.8.5.3 The vehicle shall be tested as follows:

(1) Set the road wheels in the straight-ahead position; engage neutral, and release the brakes, ensuring that there is no vehicle movement.
(2) With the engine at idle speed, measure and record the force applied to the steering rim that is necessary to turn the steering linkage from stop to stop.

5.8.5.4 The measured force shall not exceed the manufacturer's design specifications.

5.8.6 Vehicle Clearance Circle Test.

5.8.6.1 A tape measure, markers or a marking device, and a calculator shall be required.

5.8.6.2 The vehicle's steering system shall be fully operational, with the steering linkage stops adjusted within the manufacturer's specified production tolerance limits.

5.8.6.3 The vehicle shall be tested as follows:

(1) Drive the vehicle to the end of steering travel, making a left or right turn as necessary, in at least one complete circle to fully "settle" the wheels into their steady-state condition.
(2) Slowly drive the vehicle in the full cramp turn.
(3) Stop the vehicle in three locations around the turning circle, applying the brake smoothly and gradually.
(4) At each stop, mark the outermost projected point of the vehicle on the ground.
(5) Measure and record the straight line distances between the marks for each of the stop locations (length 1, length 2, and length 3).

(6) Calculate the vehicle clearance circle radius (R) as follows:

[5.8.6.3]

$$R = \frac{(\text{length 1})(\text{length 2})(\text{length 3})}{4\,[S\ (S - \text{length 1})\ (S - \text{length 2})\ (S - \text{length 3})]^{1/2}}$$

where:
S = (length 1 + length 2 + length 3)/2

(7) Repeat 5.8.6.3(1) through 5.8.6.3(6) while turning the vehicle in the opposite direction.

5.8.6.4 The vehicle's clearance circle diameter (2R) shall be less than three times the maximum overall length of the vehicle.

5.8.7 To verify the safety of the docking platform requirement in 5.5.1.3, a 317 kg/m^2 (65 lb. /ft^2) weight shall be applied for a period of 4 hours, with no platform drift.

Chapter 6 Acceptance Criteria

6.1 General.

6.1.1 Quality Assurance. The manufacturer shall provide quality assurance certification documents for the manufacturing processes of each vehicle.

6.1.2 Compliance with the requirements of this standard shall be verified by the following methods:

(1) Component manufacturer's certification
(2) Prototype vehicle tests
(3) Operational tests

6.1.3 Prototype vehicle tests shall be conducted by the manufacturer in accordance with the standardized procedures found in Section 6.3.

6.1.3.1 The manufacturer shall ensure that the performance requirements have been achieved with the design.

6.1.3.2 Calculated performance capability shall not be substituted for an actual prototype test.

6.1.4 Operational tests shall be performed either at the airport or at the manufacturer's facility as specified in Section 6.4.

6.1.5 The manufacturer of the vehicle shall demonstrate to the purchasing authority or its designee the care and maintenance and operational capability of the vehicle.

6.2 Component Manufacturer's Certification.

6.2.1 Manufacturer certification shall incorporate documentation for any new technology and shall certify that any of the components on the following list are fitted for use on all ARFF vehicles:

(1) Engine
(2) Transmission
(3) Axles
(4) Transfer case
(5) Wheels
(6) Tires
(7) Handline hose with couplings attached
(8) Premixed storage container
(9) Premixed system pressure-relief valve
(10) Propellant gas cylinder
(11) Propellant gas cylinder regulating device
(12) Complementary agent storage container
(13) Complementary agent pressure-relief device

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

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

6.2.4 Where the vehicle is equipped with an air brake system, the vehicle manufacturer shall provide itemized, certified data relative to the air system as follows:

(1) Total reservoir capacity
(2) Total required volume (12 times the total combined brake chamber volume at full stoke)
(3) Quick buildup system capacity
(4) Quick buildup system pressure needed to release the spring brakes

6.3 Prototype Vehicle Tests. Where the vehicle is fitted with an extendable turret, the test shall be conducted with the extendable turret in the stowed position.

6.3.1* Rated Water and Foam Tank Capacity Test.

6.3.1.1 Test equipment shall consist of the following:

(1) Calibrated sight gauge
(2) Liquid volume measuring device accurate to within ±1.0 percent
(3) Alternative: A stopwatch and a scale capable of measuring the total vehicle weight accurate to within ±1.0 percent

6.3.1.2 The rated water and foam tank capacity shall be determined as follows:

(1) Park the vehicle on level ground.
(2) If necessary, attach a calibrated site gauge to both the water tank and the foam tank.
(3) Fill the water piping up to a level even with the bottom of the tank. Do not record the water quantity used.
(4) While filling both tanks with a liquid volume measuring device, correlate and record the amount of water added to each tank with the site gauge calibrations. When the tanks are filled to the top, record the total liquid capacity for each tank.
(5) Alternative: After completion of (3), record the weight of the vehicle. Fill the water tank and foam tank and record the weight of the vehicle.
(6) Add dye to the foam tank.
(7) Set the agent system to discharge at the specified foam solution rate, and adjust the system discharge pressure to the recommended pressure.
(8) Starting with tanks that are completely full, discharge at maximum rate through the primary turret(s) until the agent pump(s) shows a drop in discharge pressure, and then stop immediately. Verify that dye is apparent in the discharge stream throughout the test. Record the discharge time if using the weight measurement method.

(9) Alternative: Record the weight of the vehicle after discharging. Calculate the pump-out capacity of the water tank using the weight of the water plus the foam discharged, the foam proportioning rate, and the discharge time, as previously verified.
(10) Measure the amount of liquid remaining in both tanks and convert to liters (gallons) using the conversion established in 6.3.1.2(5). Subtract the amount remaining from the total capacity to determine the amount pumped out. Record the total amount of liquid pumped out of the tanks.
(11) Refill the water tank only (not the foam tank). Discharge the water tank as in 6.3.1.2(8). Verify that dye is apparent throughout the test. Measure and record the additional amount of liquid discharged from the foam tank. Fill the water tank and discharge as many times as necessary to eliminate all usable liquid from the foam tank.
(12) Total and record the amount of liquid discharged from the foam tank from the time of initial fill.
(13) Refill both tanks and repeat 6.3.1.2(6) through 6.3.1.2(11) with the vehicle parked in the following attitudes:
    (a) 20 percent side slope, left side up
    (b) 20 percent side slope, right side up
    (c) 30 percent slope, ascending
    (d) 30 percent slope, descending
(14) After pumping on a slope, with the vehicle in each of the four slope conditions, return the vehicle to level ground to measure the water volume discharged.
(15) Divide the volume of liquid discharged from each tank on the four slope conditions by 0.85 and record.

6.3.1.3 The rated or usable water tank capacity shall be the lesser of the volumes calculated in 6.3.1.2(10) or 6.3.1.2(14).

6.3.1.4 The rated or usable foam tank capacity shall be the lesser of the volumes calculated in 6.3.1.2(12) and 6.3.1.2(14).

6.3.2* Cornering Stability.

6.3.2.1 A calibrated speedometer and a means of indicating steering wheel angle shall be required.

6.3.2.2 The vehicle shall be tested in its fully loaded condition.

6.3.2.3 A speed as outlined in Table 4.1.1(a) and Table 4.1.1(b) shall be obtained and maintained for one full revolution of the circle in accordance with SAE J2181, as follows:

(1) Slowly drive the vehicle around the 30.5 m (100 ft) radius circle while keeping the centerline of the front of the vehicle directly over the marked line.
(2) Establish a reference position on the steering wheel position indicator at a slow speed.
(3) Gradually increase the speed until the maximum speed is reached.
(4) Record the maximum speed and the corresponding position of the steering wheel.
(5) Repeat 6.3.2.3(1) through 6.3.2.3(4) while driving the vehicle in the opposite direction.

6.3.2.4 The speed achieved shall be in accordance with Table 4.1.1(a) and Table 4.1.1(b).

6.3.2.5 A double lane change test shall be conducted as follows:

(1) The vehicle shall be driven through the cones at a 40 kph (25 mph) speed in two directions.
(2) This test shall be accomplished for all prototype first article vehicles only.
(3) The vehicle shall be fully loaded and equipped for this test.

6.3.2.5.1 Test Conditions. Wind speed shall be ≤3 m/s (≤6.7 mph).

6.3.2.5.2 Test Surface. The test surface shall be a large uniform paved surface that is hard and level with a slope of ≤2 percent in all directions with a coefficient of friction of ≥0.7 and shall be dry, clean of debris, and large enough to ensure test area safety.

6.3.2.5.3 Test Track Dimensions. The double lane change track dimensions shall be as shown in Figure 6.3.2.5.3, and traffic cones shall mark the corners as shown in Figure 6.3.2.5.3.

6.3.2.5.4 Test Procedure. The test procedure shall be as follows:

(1) The operator shall drive through the first section, keeping the speed as steady as possible while driving the entire test track.
(2) The operator shall repeat the test at various speed increments until one of the following occurs:
    (a) The maximum speed for the test as specified in Table 4.1.1(a) and Table 4.1.1(b) is completed.
    (b) The limit of the vehicle's stability is attained.
    (c) It becomes impossible to cross the test track without knocking the traffic cones down.
(3) The parameters and the vehicle's behavior during the test shall be recorded.
(4) The test shall be repeated in the opposite direction.
(5) The entire test shall be repeated by a different driver.

6.3.2.5.5 Data Documentation. The following data from the test shall be documented:

(1) Characteristics of the test surface and the test dimensions
(2) Test number
(3) Direction of test
(4) Speed of test
(5) Vehicle behavior
(6) Number and position of the cones knocked down

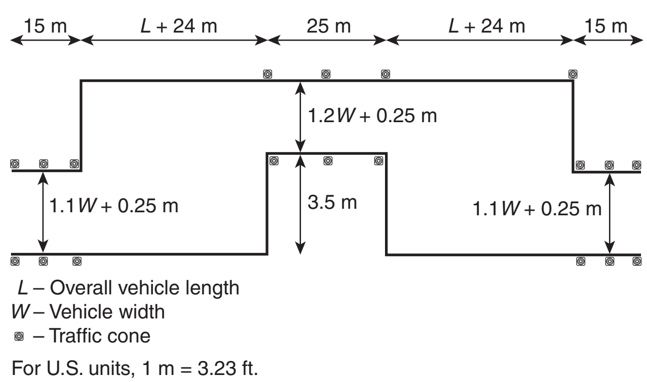

FIGURE 6.3.2.5.3 Lane Change Test Course.

6.3.2.6 The vehicle shall demonstrate the ability to traverse the "J" turn test in both directions on smooth, level pavement without the brakes being applied.

6.3.3* Vehicle Dimensions.

6.3.3.1 Test equipment shall consist of a tape measure and a protractor.

6.3.3.2 The vehicle shall be tested in its fully loaded condition with tires inflated to their recommended operating pressure.

6.3.3.3 The following vehicle dimensions shall be measured in accordance with their definitions, with the vehicle positioned on the flat pad:

(1) Angle of approach
(2) Angle of departure
(3) Interaxle clearance angle
(4) Underbody clearance
(5) Underaxle clearance

6.3.3.4 Linear dimensions shall be rounded down to the nearest 12.7 mm (½ in.), and angular dimensions shall be rounded down to the nearest ½ degree.

6.3.4* Driver Vision Measurement.

6.3.4.1 Test equipment shall consist of a plumb bob, a tape measure, and a protractor or an inclinometer.

6.3.4.2 The vehicle shall be tested in its fully loaded condition, with tires inflated to their recommended operating pressure.

6.3.4.3 The driver's range of visibility shall be determined as follows:

(1) Adjust the driver's seat to its mid position with respect to height, weight, and fore and aft adjustments.
(2) Place a structure on the seat cushion for locating an eye height of 806.5 mm (31¾ in.) and a position 304.8 mm (12 in.) forward from the seat back. Place the seat back in a vertical position.
(3) Establish the features that limit the upward and downward line of vision that are located directly in front of the driver's seat.
(4) Measure and record the angle above the horizon at which upward vision is obstructed from the eye height point established in 6.3.4.3(2).
(5) Establish the lowest possible line of vision below the horizon directly in front of the eye height point and project this line forward of the cab until it intersects with the ground. Project this line of vision by using a light beam, or, if the windshield is removed, use a string line. Measure and record the distance from this intersection with the ground and the front face of the bumper at the front of the truck.
(6) Stretch a line from the eye height point laterally across the cab in order to establish and record the 90 degree line of vision to the left and right of the straight ahead position. Note obstructions within these angles.

6.3.4.4 The recorded values for the distance at which the line of vision meets the ground in front of the truck and the angle of vision above the horizon shall equal or exceed the vehicle's specification.

6.3.4.5 Obstacles within the 90 degree horizontal line of vision to the right or left shall not create an obstruction of more than 5 degrees per obstruction.

6.3.5* Pump and Roll on a 40 Percent Grade.

6.3.5.1 Test equipment shall consist of the following:

(1) Calibrated speedometer
(2) Vehicle-equipped pump pressure gauge
(3) Load cell accurate to within ±227 kg (±500 lb) (applicable only to the alternate drawbar method)
(4) Variable load dynamometer sled (applicable only to the alternate drawbar method)

6.3.5.2 The vehicle shall have had its primary turret(s) discharge rate and pressure verified, with vehicle in its fully loaded condition with tires inflated to their recommended operating pressure, prior to beginning this test to ensure that the turret(s) discharges at or above the minimum rate specified.

6.3.5.3 The capability of the vehicle to ascend, stop, start, and continue ascent on a 40 percent grade without interruption in the discharge rate shall be demonstrated either on an actual grade or by means of an equivalent drawbar test as follows:

(1) Fill both the water and foam tanks with water and add dye to the foam tank.
(2) Set the agent system to discharge in the foam mode and set the system discharge pressure for optimum performance.
(3) Position the vehicle at the bottom of a 40 percent grade and initiate discharge at full output through the primary turret nozzles. Verify that dye is apparent in the discharge stream throughout the test.
(4) Initiate the vehicle's ascent of the grade and achieve a speed of at least 1.6 kph (1 mph). During the ascent, bring the vehicle to a stop and resume the ascent at a speed of at least 1.6 kph (1 mph) without interruption in the discharge stream. Record the vehicle speed and any variation in discharge pressure.
(5) If an actual 40 percent grade is not available, repeat 6.3.5.3(1) through 6.3.5.3(4) with the vehicle coupled to a 40 percent grade equivalent drawbar load determined as follows:
    (a) A 40 percent grade — 21.8 degree angle
    (b) The loaded vehicle weight × sin 21.8 degrees (0.371), which equals the necessary drawbar pull to simulate ascending a 40 percent grade
    (c) The area of the load cell, which can be determined at the time of the test
    (d) The load cell reading, in kPa (psi), that simulates a 40 percent grade, which can be calculated by the following:

[6.3.5.3]

$$\text{load cell reading} = \frac{\sin 21.8 \text{ degrees} \times \text{vehicle weight}}{\text{area of load cell}}$$

6.3.5.4 The vehicle shall negotiate the grade or drawbar pull smoothly while maintaining an operating pressure of at least 50 percent of the specified design pressure for the primary turret(s) at speeds of at least 1.6 kph (1 mph).

6.3.6* Electrical Charging System.

6.3.6.1 Test instrumentation shall consist of the following:

(1) A laboratory-quality voltmeter with a scale range compatible with the design voltage of the vehicle's electrical system. The scale on the voltmeter shall be graduated to allow reading voltages with a ±0.1 volt accuracy.
(2) A laboratory-quality ammeter with a scale range compatible with the anticipated electrical load present on the vehicle. The ammeter shall be graduated to allow reading current flow within a ±3 percent accuracy.
(3) The tachometer installed in the vehicle.

6.3.6.2 The test vehicle shall be tested with the following:

(1) A fully charged set of batteries
(2) Fully operational electric and charging systems
(3) Testing temperature ranges of 10°C to 32.2°C (50°F to 90°F)

6.3.6.3 Electrical System Peformance Tests.

6.3.6.3.1 The fire apparatus low voltage electrical system shall be tested as required by this section, and its subsections. [**1901:**13.14.1]

6.3.6.3.2 Tests shall be performed when the air temperature is between 0°F and 110°F (−18°C and 43°C). [**1901:**13.14.2]

6.3.6.3.3 Test Sequence.

6.3.6.3.3.1* The three tests defined in 6.3.6.3.3.2 through 6.3.6.3.3.4(D) shall be performed in the order in which they appear. [**1901:**13.14.3.1]

(A) Before each test, the batteries shall be fully charged until the voltage stabilizes at the voltage regulator set point and the lowest charge current is maintained for 10 minutes. [**1901:**13.14.3.1.1]

(B) Failure of any of these tests shall require a repeat of the sequence. [**1901:**13.14.3.1.2]

6.3.6.3.3.2 Reserve Capacity Test.

(A) The engine shall be started and kept running until the engine and engine compartment temperatures are stabilized at normal operating temperatures and the battery system is fully charged. [**1901:**13.14.3.2.1]

(B) The engine shall be shut off, and the minimum continuous electrical load shall be activated for 10 minutes. [**1901:**13.14.3.2.2]

(C) All electrical loads shall be turned off prior to attempting to restart the engine. [**1901:**13.14.3.2.3]

(D) The battery system shall then be capable of restarting the engine. [**1901:**13.14.3.2.4]

(E) Failure to restart the engine shall be considered a test failure of the battery system. [**1901:**13.14.3.2.5]

6.3.6.3.3.3 Alternator Performance Test at Idle.

(A) The minimum continuous electrical load shall be activated with the engine running at idle speed. [**1901:**13.14.3.3.1]

(B) The engine temperature shall be stabilized at normal operating temperature. [**1901:**13.14.3.3.2]

(C) The battery system shall be tested to detect the presence of battery discharge current. [**1901:**13.14.3.3.3]

(D) The detection of battery discharge current shall be considered a test failure. [**1901:**13.14.3.3.4]

6.3.6.3.3.4 Alternator Performance Test at Full Load.

(A) The total continuous electrical load shall be activated with the engine running up to the engine manufacturer's governed speed. [**1901:**13.14.3.4.1]

(B) The test duration shall be a minimum of 2 hours. [**1901:**13.14.3.4.2]

(C) Activation of the load management system shall be permitted during this test. [**1901:**13.14.3.4.3]

(D) An alarm sounded by excessive battery discharge, as detected by the warning system required in 13.3.4 [of NFPA 1901], or a system voltage of less than 11.8 V dc for a 12 V nominal system, 23.6 V dc for a 24 V nominal system, or 35.4 V dc for a 42 V nominal system for more than 120 seconds shall be considered a test failure. [**1901:**13.14.3.4.4]

6.3.6.3.4 Low Voltage Alarm Test.

6.3.6.3.4.1 The following test shall be started with the engine off and the battery voltage at or above 12 V for a 12 V nominal system, 24 V for a 24 V nominal system, or 36 V for a 42 V nominal system. [**1901:**13.14.4.1]

6.3.6.3.4.2 With the engine shut off, the total continuous electrical load shall be activated and shall continue to be applied until the excessive battery discharge alarm activates. [**1901:**13.14.4.2]

6.3.6.3.4.3 The battery voltage shall be measured at the battery terminals. [**1901:**13.14.4.3]

6.3.6.3.4.4 The test shall be considered a failure if the alarm does not sound in less than 140 seconds after the voltage drops to 11.70 V for a 12 V nominal system, 23.4 V for a 24 V nominal system, or 35.1 V for a 42 V nominal system. [**1901:**13.14.4.4]

6.3.6.3.4.5 The battery system shall then be able to restart the engine. [**1901:**13.14.4.5]

6.3.6.3.4.6 Failure to restart the engine shall be considered a test failure. [**1901:**13.14.4.6]

6.3.6.3.5 Documentation. The manufacturer shall deliver the following with the fire apparatus:

(1) Documentation of the electrical system performance tests
(2) A written electrical load analysis, including the following:
    (a) The nameplate rating of the alternator
    (b) The alternator rating under the conditions specified in 13.3.2 [of NFPA 1901]
    (c) Each of the component loads specified in 13.3.3 [of NFPA 1901] that make up the minimum continuous electrical load
    (d) Additional electrical loads that, when added to the minimum continuous electrical load, determine the total continuous electrical load
    (e) Each individual intermittent electrical load

[**1901:**13.15]

6.3.6.4 The electrical system performance shall be compared as follows:

(1) Against the specification at engine idle
(2) Also at 50 percent of engine rpm

6.3.6.5 The measured voltage of the batteries shall remain above 13 volts (for a 12-volt system) and 26 volts (for a 24-volt system) at all times while the alternator is running.

6.3.7* Radio Suppression.

6.3.7.1 Test equipment shall be in accordance with SAE J551/1 or the equivalent standard being used.

6.3.7.2 The vehicle shall be configured with all standard electrical features mounted and operational.

6.3.7.2.1 During the tests, all vehicle engines shall be operated at idle.

6.3.7.2.2 All vehicle-mounted electrical devices functioning at the crash site shall be turned on with the following stipulations:

(1) All vehicle lighting shall be on.
(2) All heating, defrosting, and air-conditioning systems, or as many systems as possible, shall be on with their respective fans adjusted to the maximum speed setting.
(3) Complementary power-generating devices (where applicable) shall be running.
(4) Intermittent warning devices, such as hazard flashers, warning buzzers, and horns, shall be turned off.

6.3.7.3 The vehicle shall be tested in accordance with SAE J551/1 or the equivalent standard being used.

6.3.7.4 The results of the test shall be evaluated in accordance with SAE J551/1 or the equivalent standard being used.

6.3.8* Gradability Test.

6.3.8.1 Test equipment shall consist of the following:

(1) Load cell accurate to within ±227 kg (±500 lb) (applicable only to the alternate drawbar method)
(2) Variable load dynamometer sled (applicable only to the alternate drawbar method)

6.3.8.2 The vehicle shall be tested in its fully loaded condition with tires inflated to their recommended operating pressure.

6.3.8.3 The capability of the fully loaded vehicle to ascend a 50 percent grade shall be demonstrated either on an actual grade or by means of an equivalent drawbar pull test. If an actual 50 percent grade is not available, then the vehicle shall be coupled to a 50 percent equivalent drawbar load, determined as follows:

(1) A 50 percent grade — 26.57 degree angle
(2) The loaded vehicle weight × sin 26.57 degrees (0.447), which equals the necessary drawbar pull to simulate ascending a 50 percent grade
(3) The area of the load cell, determined at the time of the test
(4) The load cell reading, in kPa (psi), that simulates a 50 percent grade, which can calculated by the following:

[6.3.8.3]

$$\text{load cell reading} = \frac{\sin 26.57 \text{ degrees} \times \text{vehicle weight}}{\text{area of load cell}}$$

6.3.8.4 The vehicle shall negotiate the grade or draw pull smoothly.

6.3.9* Body and Chassis Flexibility Test.

6.3.9.1 Test equipment shall consist of two to four 355.6 mm (14 in.) ramps with flat tops large enough for the tire footprint and graduated on both sides to allow the vehicle to ascend and descend.

6.3.9.2 The vehicle shall be tested in its fully loaded condition with tires inflated to their recommended operating pressure.

6.3.9.3 The vehicle shall be tested as follows:

(1) For a 4 × 4, drive the fully loaded vehicle onto 355.6 mm (14 in.) blocks positioned under the diagonally opposite front and rear wheels. For a 6 × 6, block positions correspond to axle 1 and axle 3. For an 8 × 8, block positions correspond to axle 1 and axle 4.
(2) With the vehicle in the position given in 6.3.9.3(1), take the following steps:
    (a) Inspect the vehicle thoroughly to ensure that there are no sheet metal interferences and that all moving parts are free to function.
    (b) Demonstrate all systems to ensure that they function, including discharge from all orifices.
(3) For vehicles with bogie-type construction, add a block under the second wheel of the bogie axle(s) so that both wheels on one side of the bogie are elevated simultaneously and diagonally opposite front and rear, and then repeat 6.3.9.3(2)(a) and 6.3.9.3(2)(b).
(4) Switch the blocks to the opposite sides of the truck and repeat 6.3.9.3(1) through 6.3.9.3(3).

6.3.9.4 No moving part shall interfere with another.

6.3.9.4.1 If component contact should occur, it shall in no way damage the component or detract from the vehicle's ability to carry out its mission.

6.3.9.4.2 No clearance shall be permitted between any tire and its supporting surface.

6.3.10* Service/Emergency Brake Test.

6.3.10.1 Instrumentation shall consist of the following:

(1) Calibrated fifth-wheel-type speed measuring device that is accurate to within ±0.8 kph (±0.5 mph) or ±0.5 percent of the actual vehicle speed
(2) Ground speed readout device controlled by the fifth wheel
(3) Trigger device that detects brake pedal movement
(4) Strip chart recording distance traveled, vehicle speed, and the point at which actuation of the brake system occurs

6.3.10.2 The vehicle shall be tested in its fully loaded condition with the brakes adjusted and the tires inflated to the vehicle manufacturer's specifications.

6.3.10.2.1 The brakes shall have been burnished to ensure repeatable results.

6.3.10.3 The service and emergency brake stopping distances shall be determined in the following manner:

(1) While traveling down the center of the lane established by the width of the vehicle plus 1.2 m (4 ft), attain a speed slightly above the desired test speed and release the throttle.
(2) With the strip chart recorder running, at the instant that the vehicle reaches the desired test speed, actuate the brake pedal as if in a panic stop and continue applying the brakes until the vehicle comes to a complete stop. While stopping, modulate the brake pedal as necessary to maintain vehicle control. Record the distance traveled from the time that the brake pedal is applied to the time that the vehicle comes to rest.
(3) Observe whether or not the vehicle leaves the established lane during the brake stop.
(4) Repeat 6.3.10.3(1) through 6.3.10.3(3) for a total of five stops from each test speed.
(5) Repeat 6.3.10.3(1) through 6.3.10.3(4) to obtain results at speeds of 32.2 kph (20 mph) and 64.4 kph (40 mph).
(6) Disable the front service brakes and repeat 6.3.10.3(1) through 6.3.10.3(4) at a test speed of 64.4 kph (40 mph).
(7) Reconnect the front service brakes and disable the rear service brakes and repeat 6.3.10.3(1) through 6.3.10.3(4) at a test speed of 64.4 kph (40 mph).

6.3.10.3.1 Items 6.3.10.3(6) and 6.3.10.3(7) shall not be applicable to commercial chassis.

6.3.10.4 Each of the recorded stops shall be within the specified distance without any part of the vehicle leaving the established test lane.

6.3.11* Service/Parking Brake Grade Holding Test.

6.3.11.1 Test equipment shall consist of the following:

(1) Load cell accurate to within ±227 kg (±500 lb) (applicable only to the alternate drawbar method)
(2) Variable load dynamometer sled (applicable only to the alternate drawbar method)

6.3.11.2 The vehicle shall be tested in its fully loaded condition with the brakes adjusted and the tires inflated to the vehicle manufacturer's specifications.

6.3.11.2.1 The brakes shall have been burnished to ensure repeatable results.

6.3.11.3 The capability of the vehicle's parking brake to hold the vehicle stationary on a 20 percent grade shall be demonstrated either on an actual grade or by means of an equivalent drawbar pull test. If an actual 20 percent grade is available, the tests shall be conducted as follows:

(1) Drive the vehicle in a forward direction onto the 20 percent grade, stop, and set the parking brake.
(2) Shift the transmission to neutral, and release the service brakes and verify that there is no wheel rotation.
(3) Repeat (1) and (2) with the vehicle facing the opposite direction.

6.3.11.3.1 If an actual 20 percent grade is not available, the tests shall be conducted as follows:

(1) Drive the vehicle onto the level test pad. Shift the transmission to neutral.
(2) Couple the vehicle to the horizontal force device so that forward drawbar force can be generated. Release the parking brake.
(3) Pull the vehicle forward at a speed of at least 1.6 kph (1 mph). As the vehicle is being pulled, apply the parking brake until a 20 percent equivalent drawbar is generated. A 20 percent equivalent drawbar load is determined as follows:
    (a) A 20 percent grade — 11.31 degree angle
    (b) The loaded vehicle weight × sin 11.31 degrees (0.196), which equals the necessary drawbar pull to simulate holding on a 20 percent grade
    (c) The area of the load cell, determined at the time of the test
    (d) The load cell reading, in kPa (psi), that simulates a 20 percent grade, calculated by the following:

[6.3.11.3.1]

$$\text{load cell reading} = \frac{\sin 11.31 \text{ degrees} \times \text{vehicle weight}}{\text{area of load cell}}$$

6.3.11.4 The capability of the vehicle's service brake to hold the vehicle stationary on a 50 percent grade shall be demonstrated either on an actual grade or by means of an equivalent drawbar pull test. If an actual 50 percent grade is available, the tests shall be conducted as follows:

(1) Drive the vehicle in a forward direction onto the 50 percent grade, apply the service brakes, and shift the transmission to neutral.
(2) Verify there is no wheel rotation.
(3) Repeat 6.3.11.4(1) and 6.3.11.4(2) with the vehicle facing the opposite direction.

6.3.11.4.1 If an actual 50 percent grade is not available, the tests shall be conducted as follows:

(1) Drive the vehicle onto the level test pad. Shift the transmission to neutral.
(2) Couple the vehicle to the horizontal force device so that forward drawbar force can be generated. Release the parking brake.
(3) Pull the vehicle forward at a speed of at least 1.6 kph (1 mph). As the vehicle is being pulled, apply the service brakes until a 50 percent equivalent drawbar is generated. A 50 percent equivalent drawbar load is determined as follows:
    (a) A 50 percent grade — 26.57 degree angle
    (b) The loaded vehicle weight × sin 26.57 degrees (0.447), which equals the necessary drawbar pull to simulate holding on a 50 percent grade
    (c) The area of the load cell, determined at the time of the test
    (d) The load cell reading, in kPa (psi), that simulates a 50 percent grade, calculated by the following:

[6.3.11.4.1]

$$\text{load cell reading} = \frac{\sin 26.57 \text{ degrees} \times \text{vehicle weight}}{\text{area of load cell}}$$

(4) Repeat 6.3.11.4.1(1) through 6.3.11.4.1(3) with a drawbar force applied in the rearward direction.

6.3.11.5 The capability of the vehicle's service brake to hold the vehicle stationary on a 20 percent grade shall be demonstrated either on an actual grade or by means of an equivalent drawbar pull test. If an actual 20 percent grade is available, the tests shall be conducted as follows:

(1) Drive the vehicle in a forward direction onto the 20 percent grade, apply the service brakes, and shift the transmission to neutral.
(2) Verify that there is no wheel rotation.
(3) Repeat 6.3.11.5(1) and 6.3.11.5(2) with the vehicle facing the opposite direction.

6.3.11.5.1 If an actual 20 percent grade is not available, the tests shall be conducted as follows:

(1) Drive the vehicle onto the level test pad. Shift the transmission to neutral.
(2) Couple the vehicle to the horizontal force device so that forward drawbar force can be generated. Release the parking brake.
(3) Pull the vehicle forward at a speed of at least 1.6 kph (1 mph). As the vehicle is being pulled, apply the service brakes until a 20 percent equivalent drawbar is generated. A 20 percent equivalent drawbar load is determined as follows:
    (a) A 20 percent grade — 11.31 degree angle
    (b) The loaded vehicle weight × sin 11.31 degrees (0.196), which equals the necessary drawbar pull to simulate holding on a 20 percent grade
    (c) The area of the load cell, determined at the time of the test
    (d) The load cell reading, in kPa (psi), that simulates a 20 percent grade, calculated by the following:

[6.3.11.5.1]

$$\text{load cell reading} = \frac{\sin 11.31\text{ degrees} \times \text{vehicle weight}}{\text{area of load cell}}$$

(4) Repeat 6.3.11.5.1(1) through 6.3.11.5.1(3) with a drawbar force applied in the rearward direction.

6.3.11.6 The brakes shall lock the wheels and hold the vehicle stationary on both the 20 percent and 50 percent grade (or the brakes shall generate an equivalent drawbar pull), with the vehicle pointed either uphill or downhill.

6.3.12* Steering Control Test.

6.3.12.1 Test equipment shall consist of a steering wheel and a torque meter or a spring scale.

6.3.12.2 The vehicle shall be tested in a fully loaded condition with tires inflated to their operating pressure.

6.3.12.3 The vehicle shall be tested as follows:

(1) Set the road wheels in the straight-ahead position; engage neutral, and release the brakes, ensuring that there is no vehicle movement.
(2) With the engine at idle speed, measure and record the force applied to the steering rim that is necessary to turn the steering linkage from stop to stop.

6.3.12.4 The measured force shall not exceed the manufacturer's design specifications.

6.3.13* Vehicle Clearance Circle Test.

6.3.13.1 A tape measure, markers or a marking device, and a calculator shall be required.

6.3.13.2 The vehicle's steering system shall be fully operational, with the steering linkage stops adjusted within the manufacturer's specified production tolerance limits.

6.3.13.3 The vehicle shall be tested as follows:

(1) Drive the vehicle to the end of steering travel, making a left or right turn as necessary, in at least one complete circle to fully "settle" the wheels into their steady-state condition.
(2) Slowly drive the vehicle in the full cramp turn.
(3) Stop the vehicle in three locations around the turning circle, applying the brake smoothly and gradually.
(4) At each stop, mark the outermost projected point of the vehicle on the ground.
(5) Measure and record the straight line distances between the marks for each of the stop locations (length 1, length 2, and length 3).
(6) Calculate the vehicle clearance circle radius *(R)* as follows:

[6.3.13.3]

$$R = \frac{(\text{length }1)(\text{length }2)(\text{length }3)}{4\,[S\ (S - \text{length }1)\ (S - \text{length }2)\ (S - \text{length }3)]^{1/2}}$$

where:
$S = (\text{length }1 + \text{length }2 + \text{length }3)/2$

(7) Repeat 6.3.13.3(1) through 6.3.13.3(6) while turning the vehicle in the opposite direction.

6.3.13.4 The vehicle's clearance circle diameter (2*R*) shall be less than three times the maximum overall length of the vehicle.

6.3.14* Agent Pump(s)/Tank Vent Discharge Test.

6.3.14.1 Test equipment shall consist of a liquid level measuring device accurate to within ±1.0 percent.

6.3.14.2 Each discharge nozzle on the vehicle shall have been individually verified as discharging at a flow rate at or above the minimum rate specified when the agent system is operated at the recommended pressure.

6.3.14.3 The test shall be conducted as follows:

(1) Fill the water tank and the foam tank to the top.
(2) Set the foam proportioning system to proportion foams at the concentration specified, and set the agent selector for the foam mode.
(3) Set the agent system pressure relief to the recommended pressure.
(4) Engage the agent pumps, and operate them at maximum pumping speed with all discharge outlets closed.
(5) Simultaneously initiate discharge of the primary turret(s), primary handlines, ground sweeps/bumper turret, and undertruck nozzles. After approximately 75 percent of the contents from the water tank has been discharged, simultaneously stop discharge through all nozzle outlets. Record the time of discharge.

(6) Measure and then add together the total amount of liquid discharged from the water tank and the foam tank. Calculate the average discharge rate using the discharge time from 6.3.14.3(5).
(7) Calculate the quantity of liquid used from the foam tank as a percentage of the total liquid discharged.

6.3.14.4 The measured total discharge rate shall be equal to at least the sum of the minimum specified discharge rates of the nozzles used during the test.

6.3.14.5 The calculated average foam concentration shall be within the tolerance permitted in NFPA 412, Section 5.2.

6.3.15* Water Tank Fill and Overflow Test.

6.3.15.1 Instrumentation shall consist of calibrated mechanical or electronic pressure measuring devices with an accuracy of ±3 percent and a stopwatch.

6.3.15.2 The water tank shall be empty, and the water tank fill and vent system shall be fully operational for this test.

6.3.15.3 The water tank fill and vent system shall be tested as follows to verify that the tank can be filled in 2 minutes or less:

(1) Park the vehicle on level ground.
(2) Attach one pressure measuring device at the inlet to the tank fill piping, and attach the other pressure measuring device to the tank body or an extension of the tank body.
(3) Simultaneously initiate flow to the tank and start the stopwatch. The water supply pressure shall be maintained at 551.6 kPa (80 psi) throughout the test.
(4) At the moment water begins to flow from the overflow piping, stop the watch and record the elapsed time.
(5) While maintaining a 551.6 kPa (80 psi) supply pressure and an overflow condition, record the internal tank pressure. After recording this pressure, shut off the water supply.

6.3.15.4 The results of this test shall be evaluated as follows:

(1) The time to fill the tank to the overflow condition shall be 2 minutes or less.
(2) The internal tank pressure shall not exceed the tank design pressure.

6.3.16* Flushing System Test.

6.3.16.1 No special instrumentation shall be required for this test.

6.3.16.2 The vehicle's agent system and flushing system shall be fully operational for this test.

6.3.16.3 The vehicle's flushing system shall be tested as follows:

(1) Fill the water tank and foam tank with clean water, and add dye to the foam tank.
(2) Discharge agent through each discharge orifice on the vehicle while operating in the foam mode until dye is present in the discharge stream.
(3) Mark the liquid level in the foam tank.
(4) Set the agent system in the flush mode, and discharge through each discharge orifice until clear water is present in the discharge stream.
(5) Shut the agent system down, and drain the piping.
(6) Recheck the foam tank level.

6.3.16.4 Failure to develop a clear water stream through each nozzle shall be considered evidence that the flushing system is not working.

6.3.16.5 There shall be no evidence of feedback of clear water into the foam tank.

6.3.17* Primary Turret Flow Rate Test.

6.3.17.1 Test equipment shall consist of the following:

(1) Calibrated sight gauge
(2) Liquid volume measuring device accurate to within ±1.0 percent
(3) Calibrated pressure gauge, if not already provided on the truck
(4) Alternative: A stopwatch and a scale capable of measuring total vehicle weight accurate to within ±1.0 percent of the scale capacity

6.3.17.2 It shall have been verified that the vehicle's pumping system is capable of operating at full rate.

6.3.17.3 The primary turret discharge rate shall be determined as follows:

(1) Set the primary turret pattern for straight stream operation.
(2) Fill the water tank completely.
(3) Engage the pump, and operate it at design speed.
(4) Open the turret flow control valve.
(5) If necessary, at this stage perform the following procedures:
    (a) If flow meters are used, read and record the flow rate once the discharge pressure stabilizes.
    (b) If a sight gauge is used, read and record the tank volume in gallons while simultaneously starting a stopwatch after the discharge pressure stabilizes. Read and record the tank volume in liters (gallons) when the watch is stopped after allowing flow for at least 1 minute. Determine the flow rate in L/min (gal/min) by dividing the difference in gallons by the time of discharge.
    (c) If a scale is used, record the vehicle weight prior to discharge. Start a stopwatch, and discharge water at stabilized pressure for 1 minute. Record the vehicle weight after discharge and calculate the flow rate.
(6) Reset the primary turret pattern to the dispersed setting and repeat 6.3.17.3(2) through 6.3.17.3(5).
(7) Reset the primary turret to the half flow rate setting (if applicable) and repeat 6.3.17.3(1) through 6.3.17.3(6).

6.3.17.4 The measured turret flow rates shall equal the specified flow rate within a tolerance of +10 percent/−0 percent.

6.3.18 Primary Turret Pattern Test. The primary turret pattern test shall be conducted in accordance with the requirements of NFPA 412.

6.3.19* Primary Turret Control Force Measurement.

6.3.19.1 Test equipment shall consist of a spring scale that can be attached to the end of the turret control handle or a torque measuring device that can be attached to the rotational axis of the turret.

6.3.19.2 The water tank shall be filled prior to starting the test.

6.3.19.2.1 The water tank shall have been verified that the vehicle pump system is capable of operating at design flow and pressure.

6.3.19.2.2 The test shall be conducted with the primary turret at the full flow rate setting.

6.3.19.2.3 The turret power-assist system, if applicable, shall be fully operational.

6.3.19.3 The test shall be conducted as follows:

(1) Set the turret pattern control for straight stream, and, where applicable, engage the power assist.
(2) Engage the pump, and operate it at design speed.
(3) Open the turret flow control valve.
(4) Using a spring scale attached to the end of the turret aiming handle, rotate the turret to the right and to the left, recording the needed force for each direction. Again, using the spring scale attached to the end of the turret aiming handle, elevate and depress the turret, and record the force needed to elevate and depress.
(5) Repeat 6.3.19.3(2) through 6.3.19.3(4) with the pattern control set at the maximum dispersed position after refilling the water tank as necessary.

6.3.19.4 The forces recorded shall not exceed the forces specified in 4.19.4.

6.3.20* Primary Turret Articulation Test.

6.3.20.1 The test equipment shall consist of a tape measure, a level, and a protractor.

6.3.20.2 The water tank shall be filled prior to the test.

6.3.20.2.1 The turret power-assist system, if applicable, should be fully operational.

6.3.20.3 The test shall be conducted as follows:

(1) With the turret pointed ahead, raise the turret barrel to the maximum elevated position. With a level held horizontal at the vertical rotation axis, measure the angle between the level and the turret barrel with the protractor and record.
(2) Rotate the primary turret barrel to the right and left to the angle needed.
(3) Place a marker 9.1 m (30 ft) in front of the vehicle. Aim the turret straight ahead with the rate control at full flow, with the pattern control in the maximum dispersed position and with the turret in the maximum depressed position. When water discharges, observe whether water strikes the marker or strikes closer to the vehicle.

6.3.20.4 Turret articulation shall be considered as passing if the measurements meet or exceed the specifications.

6.3.21* Handline Nozzle Flow Rate Test.

6.3.21.1 Test equipment shall consist of the following:

(1) Calibrated sight gauge
(2) Liquid volume measuring device accurate to within ±1.0 percent
(3) Calibrated pressure gauge, if not already provided on the truck
(4) Alternative: A stopwatch and a scale capable of measuring total vehicle weight accurate to within ±1.0 percent

6.3.21.2 The vehicle's pumping system shall be verified to be capable of operating at full rate.

6.3.21.3 The handline nozzle flow rate shall be determined as follows:

(1) Set the handline nozzle pattern for straight stream operation.
(2) Fill the water tank completely.
(3) Engage the pump and operate it at design speed.
(4) Open the handline nozzle flow control valve.
(5) If necessary, at this stage perform the following procedures:
   (a) If flow meters are used, read and record the flow rate once the discharge pressure stabilizes.
   (b) If a sight gauge is used, read and record the tank volume in gallons while simultaneously starting a stopwatch after the discharge pressure stabilizes. Read and record the tank volume in liters (gallons) when the watch is stopped after allowing flow for at least 5 minutes. Determine the flow rate in L/min by dividing the difference in gallons by the time of discharge.
   (c) If an open-top calibrated tank is used, discharge through the nozzle until the pressure stabilizes, and then simultaneously direct the stream into the tank while starting the stopwatch. Stop the stopwatch when the tank is full, and remove or shut off the nozzle. Determine the flow rate by dividing the tank volume in liters (gallons) by the fill time in minutes.
   (d) If a scale is used, record the vehicle weight prior to discharge. Start a stopwatch, and discharge water at stabilized pressure for 1 minute. Record the vehicle weight after discharge, and calculate flow rate.
(6) If the nozzle is the non-air-aspirated type, repeat 6.3.21.3(2) through 6.3.21.3(5) with the nozzle pattern setting in the fully dispersed position.

6.3.21.4 The measured handline nozzle flow rates shall equal the specified flow rate within a tolerance of +10 percent/ −0 percent.

6.3.22 Handline Nozzle Pattern Test. The handline nozzle pattern test shall be conducted in accordance with the requirements of NFPA 412.

6.3.23* Ground Sweep/Bumper Turret Flow Rate Test.

6.3.23.1 Test equipment shall consist of the following:

(1) Calibrated sight gauge
(2) Liquid volume measuring device accurate to within ±1.0 percent
(3) Calibrated pressure gauge, if not already provided on the truck
(4) Alternative: A stopwatch and a scale capable of measuring total vehicle weight accurate to within ±1.0 percent

6.3.23.2 The vehicle's pumping system shall be verified to be capable of operating at full rate.

6.3.23.3 The ground sweep/bumper turret discharge rate shall be determined as follows:

(1) Set the ground sweep/bumper turret pattern for straight stream operation.
(2) Fill the water tank completely.
(3) Engage the pump and operate it at design speed.
(4) Open the ground sweep/bumper turret flow control valve.

(5) If necessary, at this stage perform the following procedures:

  (a) If flow meters are used, read and record the flow rate once the discharge pressure stabilizes.
  (b) If a sight gauge is used, read and record the tank volume in gallons while simultaneously starting a stopwatch after the discharge pressure stabilizes. Read and record the tank volume in liters (gallons) when the watch is stopped after allowing flow for at least 1 minute. Determine the flow rate in L/min by dividing the difference in gallons by the time of discharge.
  (c) If a scale is used, record the vehicle weight prior to discharge. Start a stopwatch, and discharge water at stabilized pressure for 1 minute. Record the vehicle weight after discharge, and calculate the flow rate.

(6) If the ground sweep/bumper turret is the non-air-aspirated type, repeat 6.3.23.3(2) through 6.3.23.3(5) with the nozzle pattern setting in the fully dispersed position.

6.3.23.4 The measured flow rates shall equal the specified flow rate within a tolerance of +10 percent/−0 percent.

6.3.24 Ground Sweep/Bumper Turret Pattern Test. The ground sweep/bumper turret pattern test shall be conducted in accordance with the requirements of NFPA 412.

6.3.25* Undertruck Nozzle Test.

6.3.25.1 Markers shall be available for use in defining the pattern boundaries.

6.3.25.2 The vehicle's pump system shall be verified to be capable of operating at full rate.

6.3.25.2.1 The agent tanks shall be filled with water and foam, respectively.

6.3.25.3 The test shall be conducted as follows:

(1) Set the agent system to operate in the foam mode.
(2) Engage the agent pump and operate it at design speed.
(3) Open the undertruck nozzles to discharge simultaneously, and continue to discharge until a definite pattern outline is apparent.
(4) Close the discharge and mark and record the boundaries of the pattern.

6.3.25.4 The pattern shall be considered acceptable if the foam spray covers the outline created by the vehicle on the ground and wets the inside of all tires.

6.3.26* Foam Concentration/Foam Quality Test.

6.3.26.1 The test equipment described in NFPA 412 shall be used for this test.

6.3.26.2 Each discharge nozzle on the vehicle shall have been individually verified as discharging at a flow rate within the tolerance specified.

6.3.26.2.1 The agent system shall have been verified as capable of operating at full rate.

6.3.26.3 The test shall be conducted as follows:

(1) Fill the water tank and the foam tank to the top, and refill as necessary throughout the test.
(2) Set the foam proportioning system to proportion foams at the concentration specified, and set the agent selector for the foam mode.
(3) Set the agent system pressure relief to the recommended pressure.
(4) Engage the agent pumps, and operate them at maximum pumping speed with all discharge outlets closed.
(5) Test each foam delivery system first for the individual nozzle/flow rate specified in the following list and then for a total combined simultaneous discharge in accordance with NFPA 412:

  (a) Primary turret(s) full rate
  (b) Primary turret(s) half rate
  (c) Ground sweep/bumper turret
  (d) Handline nozzles
  (e) Undertruck nozzles

6.3.26.4 The foam concentrations measured shall fall within the permitted tolerances specified in NFPA 412 for each nozzle and for the combined simultaneous discharge.

6.3.26.4.1 The foam expansion and drainage time measurements shall equal or exceed those specified in NFPA 412 for each nozzle.

6.3.27* Warning Siren Test.

6.3.27.1 Test equipment shall consist of the following:

(1) Sound level meter that meets the requirements of ANSI S1.4 for Type 1 or S1A meters and has been calibrated by a certified testing laboratory within the previous 12 months
(2) Tape measure

6.3.27.2 The capability of the warning siren on the vehicle to project sound forward and to the sides shall be determined as follows:

(1) Set the sound level meter to the A-weighing network, "fast" meter response, and position the meter directly ahead of the vehicle at a distance of 30.5 m (100 ft) from the front bumper, with the microphone at ear level of a 95th percentile male.
(2) Energize the siren and record the meter reading.
(3) Repeat 6.3.27.2(1) and 6.3.27.2(2) with the sound level meter 30.5 m (100 ft) from the vehicle, first at a position 45 degrees to the right and then at 45 degrees to the left of the longitudinal centerline of the vehicle.

6.3.27.3 The recorded noise level shall equal or exceed the specifications.

6.3.28* Propellant Gas.

6.3.28.1 Test equipment shall consist of a calibrated scale or load cell with an accuracy of ±1.0 percent.

6.3.28.2 The vehicle extinguishing agent piping system shall be operational.

6.3.28.2.1 The agent tank(s) shall be empty.

6.3.28.2.2 The propellant gas tank(s) shall be fully charged to the rated pressure.

6.3.28.2.3 A means of lifting the agent tanks for weighing without loss of agent shall be provided.

6.3.28.2.4 As an alternative, the extinguishing agent tank(s) shall be permitted to be tested outside of the vehicle.

6.3.28.2.5 Where the alternative in 6.3.28.2.4 is used, the test shall be conducted with the agent tank(s) and related piping, fittings, valves, hose, and nozzle(s) in the same configurations in which they are installed on the vehicle.

6.3.28.3 The test for each of the extinguishing agents shall be conducted in the following manner:

(1) Weigh the empty tank(s) and record as tare weight.
(2) Using the manufacturer's recommended filling procedure, charge the tank(s) with the manufacturer's recommended extinguishing agent to the upper fill weight/volume tolerance. Reweigh and record this as gross filled weight.
(3) Ensure that all fill caps are tightened, all propellant gas lines are connected, the discharge nozzle(s) is in the closed position, and all fittings and connections are tight.
(4) Pressurize the agent tank(s) using the manufacturer's recommended procedure.
(5) Simultaneously, fully open all discharge nozzles, and keep open until only the pressurizing gas is expelled.
(6) Shut down the propellant gas supply.
(7) Reweigh the agent tank(s) and record this as post-discharge weight.
(8) Calculate and record the total agent discharged as follows:
Gross filled weight – post-discharge weight = total agent discharge

6.3.28.4 There shall be a supply of propellant gas to purge all discharge lines as evidenced by the emission from each nozzle of gas only.

6.3.29* Pressure Regulation.

6.3.29.1 Test equipment shall consist of a calibrated pressure gauge or transducer capable of reading the recommended tank top discharge pressure and possessing an accuracy of ±34.5 kPa (±5.0 psi).

6.3.29.2 The vehicle extinguishing agent system shall be piped to all discharge outlets with the tank(s) empty.

6.3.29.2.1 The propellant gas tank(s) shall be fully charged and at pressure.

6.3.29.2.2 A means for mounting a pressure gauge or transducer somewhere between the downstream (low-pressure) side of the regulator and the agent tank top shall be provided.

6.3.29.2.3 As an alternative, the extinguishing agent tank(s) shall be permitted to be tested outside of the vehicle.

6.3.29.2.4 Where the alternative in 6.3.29.2.3 is used, the test shall be conducted with the agent tank(s) and related piping, fittings, valves, hose, and nozzle(s) in the same configuration in which they are installed on the vehicle.

6.3.29.3 The test for each of the extinguishing agents shall be conducted in the following manner:

(1) Using the manufacturer's recommended filling procedure, charge the tank(s) with the manufacturer's recommended extinguishing agent to the upper fill weight/volume tolerance.
(2) Install a pressure gauge or transducer between the downstream (low-pressure) side of the regulator and the agent tank top.
(3) Ensure that all fill caps are tightened, all propellant gas lines are connected, the discharge nozzle(s) is in the closed position, and all fittings are tight.
(4) Pressurize the agent tank(s) using the manufacturer's recommended procedure. Record the agent tank pressure.
(5) Simultaneously, fully open all discharge nozzles, and keep open until only the pressurizing gas is expelled.
(6) During agent discharge, monitor agent tank pressure and record at 5-second or shorter intervals.
(7) Once the gas point has been reached for all discharge nozzles, shut down the gas supply.

6.3.29.4 The pressure regulation system shall be capable of maintaining pressure throughout the discharge.

6.3.29.4.1 At no time shall pressure fall below or exceed the design range specified by the manufacturer.

6.3.30* AFFF Premix Piping and Valves.

6.3.30.1 Test equipment shall consist of the following:

(1) Calibrated scale or load cell with an accuracy of ±1.0 percent
(2) Stopwatch

6.3.30.2 All vehicle foam discharge piping shall be operational, and the premix tank shall be empty.

6.3.30.2.1 The propellant gas tank(s) shall be fully charged and within pressure.

6.3.30.2.2 A means of lifting the agent tank(s) for weighing without loss of agent shall be provided.

6.3.30.2.3 As an alternative, the system shall be permitted to be tested outside of the vehicle.

6.3.30.2.4 Where the alternative in 6.3.30.2.3 is used, the test shall be conducted with the premix tank and related piping, fittings, valves, hose, and nozzle(s) in the same configuration in which they are installed on the vehicle.

6.3.30.3 The test shall be conducted in the following manner:

(1) Weigh the empty premix tank and record as tare weight.
(2) Using the manufacturer's recommended filling procedure, charge the tank with water or premix solution. Reweigh and record as gross filled weight.
(3) Ensure that all fill caps are tightened, all propellant gas lines are connected, the discharge nozzle(s) is in the closed position, and all fittings and connections are tight.
(4) Pull all handline hose from the reel(s) or hose compartment(s).
(5) Pressurize the system using the manufacturer's recommended procedure.
(6) Simultaneously, start the stopwatch and fully open the turret(s), undertruck nozzles, and handline(s).
(7) After discharging for at least 30 seconds, simultaneously stop the stopwatch and close the turret(s), undertruck nozzles, and handline(s). Record the elapsed time on the stopwatch as discharge time.
(8) Following the manufacturer's instructions, shut off the propellant gas supply, and blow down the system.
(9) Reweigh the premix tank and record this as post-discharge weight.

(10) Add the recommended flow rates from each discharge nozzle and record this sum as the designed total flow rate.
(11) Calculate the actual total flow rate (TFR) as follows:

[6.3.30.3]

$$TFR = \frac{\text{gross filled weight} - \text{post-discharge weight}}{(\text{density}) \times \dfrac{(\text{elapsed time in seconds})}{60}}$$

6.3.30.4 The actual TFR shall equal the specified flow rate designed within a tolerance of +10 percent/−0 percent.

6.3.31* Pressurized Agent Purging and Venting.

6.3.31.1 No special test equipment or instrumentation shall be required to conduct the test(s).

6.3.31.2 The vehicle extinguishing agent system(s) shall be fully operational.

6.3.31.2.1 The agent tank(s) shall be fully charged with the manufacturer's recommended agent.

6.3.31.2.2 The propellant gas tank(s) shall be fully charged to the rated pressure.

6.3.31.2.3 As an alternative, the extinguishing agent tank(s) shall be permitted to be tested outside of the vehicle.

6.3.31.2.4 Where the alternative in 6.3.31.2.3 is used, the test shall be conducted with the fully charged agent tank(s) and related piping, fittings, valves, hose, and nozzle(s) in the same configuration in which they are installed on the vehicle.

6.3.31.3 The test for each of the pressurized extinguishing agent systems shall be conducted in the following manner:

(1) Pressurize the agent tank(s) using the manufacturer's recommended procedure.
(2) Pull all hose from the reel(s) or compartment(s).
(3) Fully open all discharge devices.
(4) After approximately 5 seconds to 20 seconds, close all discharge devices.
(5) Purge all discharge lines, and vent the agent tank(s) using the manufacturer's recommended procedure.

6.3.31.4 Any agent beyond the tank outlet shall be purged from the discharge piping and hose as evidenced by the discharge from each nozzle of gas only.

6.3.31.4.1 The depressurization or venting of the agent tank shall allow only minimal quantities of agent to escape.

6.3.32* Complementary Agent Handline Flow Rate and Range.

6.3.32.1 Test equipment shall consist of the following:

(1) Calibrated scale or load cell with an accuracy of ±1.0 percent
(2) Stopwatch
(3) Tape measure or other device for measuring distance
(4) Calibrated anemometer
(5) Pan containing at least 0.09 m^2 (1 ft^2) of motor or aviation gasoline
(6) Agent tank (if equipped with an agent tank) with a liquid level gauge with accuracy of ±1.13 kg (2.5 lb)

6.3.32.2 All vehicle agent piping shall be operational.

6.3.32.2.1 The agent tank shall be empty.

6.3.32.2.2 The propellant gas tank(s) shall be fully charged and within pressure.

6.3.32.2.3 A means of lifting the agent tank(s) for weighing without loss of agent shall be provided.

6.3.32.2.4 As an alternative, the system shall be permitted to be tested outside of the vehicle.

6.3.32.2.5 Where the alternative in 6.3.32.2.4 is used, the test shall be conducted with the agent tank and related piping, fittings, valves, hose, and nozzle(s) in the same configuration in which they are installed on the vehicle.

6.3.32.3 The test shall be conducted in the following manner:

(1) Using the manufacturer's recommended agent and filling procedure, charge the agent tank.
(2) If weight discharged will be based on liquid level gauge readings, record liquid level gauge reading in 9 kg (20 lb) increments, based on weighing of agent supply cylinder, as tank is initially filled.
(3) Ensure that all fill caps are tightened, all propellant gas lines are connected, the discharge nozzle(s) is in the closed position, and all fittings and connections are tight.
(4) Pull all handline hose from the reel(s).
(5) Pressurize the system using the manufacturer's recommended procedure, and open all handline nozzles until agent flow is observed. Close the nozzles.
(6) Activate system and purge handline of air by opening the handline nozzle for approximately 1 second.
(7) Weigh or note weight based on liquid level gauge reading, and record the agent tank as the "initial weight."
(8) Position the handline nozzles at least 6.1 m (20 ft) from the fire pan so that they can be discharged onto a flat grade with no stream obstructions. Ignite the fuel.
(9) Select one of the handline nozzles (nozzle 1). While holding it in a position 0.9 m to 1.2 m (3 ft to 4 ft) above ground level, simultaneously start the stopwatch and fully open the nozzle; then discharge agent onto the fire.
(10) After at least 50 percent of the contents of the tank has been discharged, shut down the nozzle and stop the stopwatch. Record the time as "elapsed discharge time no. 1."
(11) Reweigh the agent tank, and record as "weight after first discharge."
(12) If a second nozzle (nozzle 2) is provided, repeat 6.3.32.3(1) through 6.3.32.3(8).
(13) While holding the two handline nozzles in a fixed horizontal position 0.9 m to 1.2 m (3 ft to 4 ft) above ground level, simultaneously start the stopwatch and fully open both nozzles.
(14) After at least 50 percent of the contents of the tank has been discharged, simultaneously shut down both nozzles, and stop the stopwatch. Record the time as "elapsed discharge time no. 2."
(15) Reweigh the agent tank, and record as "weight after second discharge."

(16) Calculate the flow rate (FR) from nozzle 1 as follows:

[6.3.32.3a]

$$FR = \frac{\text{initial weight (test 1)} - \text{initial weight (test 2)}}{\text{(elapsed discharge time no. 1)}}$$

(17) Calculate the flow rate (FR) from nozzle 2 as follows:

[6.3.32.3b]

$$FR = \frac{\begin{matrix}\text{weight after} \\ \text{first discharge}\end{matrix} - \begin{matrix}\text{weight after} \\ \text{second discharge}\end{matrix}}{2 \times \text{(elapsed discharge time no. 2)}}$$

(18) If nozzle 2 is of a different configuration, repeat the fire test for this nozzle.

6.3.32.4 Test results shall be evaluated as follows:

(1) The flow rate from each nozzle shall meet the requirement.
(2) The range from each nozzle shall meet or exceed the requirements as evidenced by extinguishment of the fire(s).
(3) When discharged simultaneously, the flows from nozzle 1 and nozzle 2 shall be within 10 percent of each other.

6.3.33* Dry Chemical Turret Flow Rate and Range.

6.3.33.1 Test equipment should consist of the following:

(1) Calibrated scale or load cell with an accuracy of ±1.0 percent
(2) Stopwatch
(3) Tape measure or other device for measuring distance
(4) Calibrated anemometer

6.3.33.2 All dry chemical discharge piping shall be operational.

6.3.33.2.1 The dry chemical tank shall be empty.

6.3.33.2.2 The propellant gas tank(s) shall be fully charged to the rated pressure.

6.3.33.2.3 A means of lifting the agent tank(s) for weighing without loss of agent shall be provided.

6.3.33.2.4 As an alternative, the system shall be permitted to be tested outside of the vehicle.

6.3.33.2.5 Where the alternative in 6.3.33.2.4 is used, the test shall be conducted with the agent tank and related piping, fittings, valves, hose, and nozzle(s) in the same configuration in which they are installed on the vehicle.

6.3.33.3 The test shall be conducted in the following manner:

(1) Using the manufacturer's recommended agent and filling procedure, charge the tank.
(2) Ensure that all fill caps are tightened, all propellant gas lines are connected, the discharge nozzle(s) is in the closed position, and all fittings and connections are tight.
(3) Pressurize the system using the manufacturer's recommended procedure, and open the turret discharge valve until agent is observed. Close the valve.
(4) Weigh and record the agent tank as the "initial test weight."
(5) Position the dry chemical turret so that it can be discharged onto a flat grade with no stream obstructions. Position the turret to obtain maximum straight stream reach.
(6) Simultaneously, start the stopwatch and fully open the turret.
(7) During discharge, place markers at the far point where dry chemical strikes the ground (range marker) and at either side of the widest part of the pattern (width markers), following these procedures:
    (a) The operator(s) placing the markers shall wear safety equipment for this task.
    (b) The agent manufacturer's material safety data sheet shall be consulted.
(8) After discharging at least 75 percent of the contents of the tank, simultaneously stop the stopwatch and shut down the turret. Record the elapsed time in seconds as discharge time.
(9) Measure the distance from the turret to the range marker and record as the far point range.
(10) Measure the distance between the width markers and record as the pattern width.
(11) Reweigh the agent tank and record as the weight after discharge.
(12) Calculate the flow rate (FR) as follows:

[6.3.33.3]

$$FR = \frac{\text{initial test weight} - \text{weight after discharge}}{\text{elapsed discharge time}}$$

6.3.33.4 The stream range and pattern width shall equal or exceed the requirements.

6.3.33.4.1 The discharge flow rate shall equal the requirements in Table 4.1.1(a) and Table 4.1.1(b).

6.3.34* Cab Interior Noise Test.

6.3.34.1 Test equipment shall consist of a sound level meter that meets the requirements of ANSI S1.4 for Type 1 or S1A meters.

6.3.34.1.1 The sound level meter shall have been calibrated by a certified testing laboratory within the previous 12 months.

6.3.34.2 The vehicle shall be tested in its fully loaded condition with tires inflated to their recommended inflation pressure.

6.3.34.2.1 The cab doors, windows, and hatch openings shall be closed during this test.

6.3.34.2.2 The vehicle shall be driven long enough to bring the drivetrain components up to their operating temperatures prior to starting the test.

6.3.34.2.3 Thermostatically controlled shutters or cooling fans, or both, shall be allowed to function.

6.3.34.2.4 The vehicle agent system(s), the communications system, and the audible warning system and emergency warning system shall be inactive during this test.

6.3.34.3 The interior noise level of the cab shall be determined as follows:

(1) Set the sound level meter to the A-weighing network, "fast" meter response, and position the meter adjacent to the driver's ear.
(2) Bring the vehicle up to a road speed of 80.5 kph (50 mph) and maintain that speed while recording the noise measurements.
(3) Repeat 6.3.34.3(1) and 6.3.34.3(2) until four readings have been taken, bringing the vehicle to rest between each measurement. If any of the noise measurements differ from the others by more than 2 dBA, they should be replaced by another measurement, since they could be the result of extraneous ambient noises or equipment/measurement error.
(4) Average the four readings.

6.3.34.4 The average of the recorded noise readings shall be less than or equal to the cab interior noise level specification specified in 4.12.3.3.

6.3.34.4.1 Halon 1211 systems shall not be tested.

6.4* Operational Tests.

6.4.1 Vehicle Testing, Side Slope.

6.4.1.1 This test shall be accomplished on a vehicle prior to the vehicle being delivered to the end user.

6.4.1.1.1 It shall be accomplished with all requested equipment placed and installed as ordered by the end user.

6.4.1.1.2 The tilt-table angle shall be recorded on a metal data plate affixed to the left door of the vehicle.

6.4.1.1.3 The data plate shall list the following items:

(1) Vehicle empty weight
(2) Maximum gross weight
(3) Special equipment installed prior to test
(4) Front and rear axle weights with weight distribution calculation

6.4.1.1.4 The actual tilt-table angle achieved in the test shall be recorded on the plate for left and right directions.

6.4.1.1.4.1 The test shall be conducted on a tilt-table facility meeting the following SAE J2180 requirements:

(1) The tilt table shall contain a suitable surface to resist truck sliding during test sequences.
(2) The vehicle shall be restrained and tilted until the vehicle tilt or side slope angle can be positively determined.

6.4.1.2 The vehicle shall be tested in its fully loaded condition with tires inflated to their recommended operating pressure.

6.4.1.2.1 A ballast shall be used in place of the crew for safety.

6.4.1.3 Where the vehicle is fitted with an extendable turret, an additional test shall be performed as follows:

(1) Tilt the vehicle on a table or position the vehicle on a 20 percent grade.
(2) Elevate the extendable turret to the highest elevation.
(3) Position the turret nozzle uphill at maximum horizontal rotation and discharge the agent at maximum flow rate for the class of vehicle being tested.

6.4.1.4 The side slope capability of the vehicle shall be determined in accordance with SAE J2180, and as follows:

(1) Tilt the vehicle on a table to the angle specified for the vehicle being tested.
(2) Once the vehicle is positioned at the required angle, check the vehicle restraints to ensure that no tension is applied.

6.4.1.5 The vehicle shall be considered to meet its side slope requirement if the vehicle can stand by itself on the grade without the use of the safety restraints.

6.4.1.6 Where multiple vehicles are purchased under the same contract and built to exactly the same specifications, the purchaser shall be permitted to have a single unit or a random sample of units tested and the result(s) applied to the other identical units.

6.4.2* Weight/Weight Distribution.

6.4.2.1 Instrumentation for the weight and weight distribution test shall be limited to in-ground or portable scales.

6.4.2.1.1 The accuracy of the scales shall be ±1.0 percent of the scale capacity.

6.4.2.2 The vehicle shall be tested in its fully loaded condition.

6.4.2.2.1 Ballast shall be used for the crew and equipment as necessary.

6.4.2.3 The total weight of the vehicle and weight distribution shall be determined as follows:

(1) Determine the total weight of the vehicle by driving the fully loaded vehicle onto the scale(s).
(2) Determine the individual axle loadings by measuring the weight on each axle at the ground. Since the total vehicle weight is more accurately reflected by the single weight measurement in 6.4.2.3(1), correct the individual axle loads proportionately, as necessary, so that their total equals the total vehicle weight. Subtract the lightest loaded axle weight from the heaviest loaded axle weight, and divide the difference by the weight of the heaviest axle.
(3) Determine individual tire loadings by measuring the weight on each tire at the ground. Make proportionate corrections to the individual tire loads so that their total equals the load on the respective axle. Determine the average tire weight for each axle by adding the right-hand and left-hand tire weights for each axle and dividing by 2. Subtract the lightest loaded tire weight from the heaviest loaded tire weight for each axle, and divide the difference by the average tire load for that axle.

6.4.2.4 The data shall be evaluated on the following basis:

(1) The total weight of the vehicle shall be less than or equal to the vehicle manufacturer's gross vehicle weight rating.
(2) The difference between the heaviest loaded axle and the lightest loaded axle shall be less than or equal to the maximum difference permitted in the specification.
(3) The difference between the tire weights on any given axle shall be less than or equal to the maximum difference permitted in the specification.

6.4.3* Acceleration.

6.4.3.1 Ambient temperatures at the test site shall be –17.8°C to 43.3°C (0°F to 110°F), and elevations shall include heights up to 609.6 m (2000 ft) unless otherwise specified by the purchaser.

6.4.3.2 Instrumentation shall consist of a fifth wheel device, or equivalent, designed to measure and record (at least visibility as a minimum) vehicle speed and time from the time the vehicle begins to move until it reaches a predetermined top speed.

6.4.3.3 The vehicle shall be tested in its fully loaded condition with the engine and the transmission at their operating temperatures.

6.4.3.3.1 The tires shall be inflated to the manufacturer's recommended pressure.

6.4.3.4 The test shall be conducted in the following manner:

(1) Start the test with the vehicle at rest, the engine at idle, and the transmission in gear.
(2) Simultaneously, start the stopwatch and accelerate the vehicle, and continue accelerating to a wide-open throttle condition.
(3) At the moment the vehicle reaches 80.5 kph (50 mph), stop the watch and record the elapsed time.
(4) To compensate for wind conditions and slope, repeat the test in the opposing direction. Record and average a minimum of three readings in each of the two directions.

6.4.3.5 The average acceleration time to 80.5 kph (50 mph) shall be less than or equal to the requirements specified in Table 4.1.1(a) and Table 4.1.1(b).

6.4.4* Top Speed.

6.4.4.1 Instrumentation shall consist of the vehicle's speedometer as installed by the manufacturer at the time of delivery.

6.4.4.2 The vehicle shall be tested in its fully loaded condition with the engine and the transmission at their operating temperatures.

6.4.4.2.1 The tires shall be inflated to the manufacturer’s recommended pressure.

6.4.4.3 The test shall be conducted in the following manner:

(1) Accelerate the vehicle to the speed specified in Table 4.1.1(a) and Table 4.1.1(b).
(2) To compensate for wind conditions and slope, repeat the test in the opposing direction.
(3) If the specified speed cannot be achieved in one of the directions, repeat 6.4.4.3(1) and 6.4.4.3(2), accelerating the vehicle to its maximum speed in each direction; record the speeds and average the two numbers.

6.4.4.4 The test shall be considered successful if the average top speed equals or exceeds 104.6 kph (65 mph).

6.4.5* Brake Operational Test.

6.4.5.1 Instrumentation shall consist of the vehicle's speedometer, as installed by the manufacturer, and a tape measure.

6.4.5.2 The vehicle shall be tested in its fully loaded condition with the brakes adjusted to the manufacturer's recommended tolerances.

6.4.5.2.1 The tires shall be inflated to the vehicle manufacturer's recommended inflation pressure.

6.4.5.2.2 The vehicle's stopping distance shall have been certified by the vehicle manufacturer.

6.4.5.3 The test shall be conducted in the following manner:

(1) Maintain a constant speed of 32.2 kph (20 mph) while driving down the centerline of the test site.
(2) Apply the brakes as if in a panic stop until the vehicle comes to rest.
(3) Measure and record the distance from the outer edge of the vehicle to the centerline of the lane.
(4) Repeat 6.4.5.3(1) through 6.4.5.3(3) at a constant speed of 64.4 kph (40 mph).

6.4.5.4 The distance measured shall not exceed one-half the vehicle width plus 0.6 m (2 ft).

6.4.6 Air System/Air Compressor Test.

6.4.6.1 Instrumentation shall consist of the vehicle's air system pressure gauge(s), as installed by the manufacturer, and a stopwatch.

6.4.6.2 The vehicle's air system shall be fully operational for this test.

6.4.6.2.1 The manufacturer previously shall have established the ratio of actual to required reservoir capacity and the spring brake release pressure.

6.4.6.2.2 The test shall be conducted with the transmission in neutral and the parking brakes set.

6.4.6.3 The test shall be conducted as follows:

(1) Using the brake pedal, bleed off the air reservoir system pressure to a level below 586 kPa (85 psi) as indicated on the cab-mounted air gauge(s).
(2) Accelerate the engine to its wide-open throttle condition.
(3) When the air pressure indicator reaches 586 kPa (85 psi), start the stopwatch. If more than one air pressure indicator is installed on the vehicle, start the stopwatch when the first indicator registers 586 kPa (85 psi).
(4) Continue building air pressure with the engine at wide-open throttle until 689.5 kPa (100 psi) registers on all air pressure indicators, stop the watch, and record the time.
(5) Using the brake pedal, bleed off the air reservoir system pressure to 0 kPa (0 psi), as indicated on the cab-mounted air gauge(s).
(6) Accelerate the engine to a wide-open throttle condition.
(7) When the wide-open throttle condition is reached, simultaneously start the stopwatch.
(8) Continue building air pressure with the engine at wide-open throttle until the previously established spring brake release pressure has been reached in the quick buildup system; stop the watch and record the time.

6.4.6.4 The results shall be evaluated as follows:

(1) The time needed for a buildup of 586 kPa to 689.5 kPa (85 psi to 100 psi) shall be within 25 seconds of the permitted time, as calculated for larger reservoir capacities.
(2) The quick buildup time shall be within 15 seconds.

6.4.7* Agent Discharge Pumping Test.

6.4.7.1 No test equipment shall be required.

6.4.7.2 The vehicle's agent system shall be fully operational with all primary handlines deployed for this test.

6.4.7.3 The simultaneous discharge of all nozzles shall be tested as follows:

(1) Fill both the water tank and the foam (or dyed water) tank completely with water and foam, respectively.
(2) Set the agent system to operate in the foam mode, set the system pressure for optimum performance, and engage the agent pumps. Simultaneously, operate the pumps of vehicles with multiple pumps during this test.
(3) Initiate discharge first through the primary turret and then through the ground sweeps (or optional bumper turret), primary handlines, and undertruck nozzles until all are discharging simultaneously in a straight stream. As each nozzle is turned on, observe the range along with the system pressure.
(4) Continue to discharge until the system pressure has stabilized with all nozzles discharging.

6.4.7.4 Since measurements of actual flow rates are not accurately obtained in the field, the system shall be considered to have met the agent discharge pumping test requirement in accordance with the procedures of 6.4.7.3, provided the nozzle ranges show no signs of deterioration as additional nozzles are engaged and the agent system pressure does not fluctuate by more than 10 percent where the primary turret flowing by itself is compared with the combined discharge pressure.

6.4.7.5 Foam (or dyed water) shall be evident in the discharging stream from all nozzles at all times.

6.4.8* Dual Pumping System Test.

6.4.8.1 No special instrumentation shall be required for this test.

6.4.8.2 The vehicle's agent system shall be fully operational for this test.

6.4.8.3 The ability of a vehicle equipped with a dual pumping system to provide foam solution to all nozzles when only one system is active shall be tested as follows:

(1) Fill both the water tank and the foam tank completely with water, and add dye or foam concentrate to the foam tank.
(2) Set the agent system to operate in the foam mode, and set the system pressure for optimum performance.
(3) Set the primary turret(s) discharge rate in the half flow rate setting.
(4) Initiate discharge first through the primary turret(s) (at half rate) and then through the ground sweep nozzles (or alternate bumper turret), the primary handline nozzles, and the undertruck nozzles, first with one pump operating, and then the other.

6.4.8.4 A foam or dye solution discharge stream shall be present at each nozzle tested when either pump is engaged.

6.4.9* Pump and Maneuver Test.

6.4.9.1 No test equipment shall be required.

6.4.9.2 The vehicle's agent system shall be fully operational for this test.

6.4.9.3 The positive pump and maneuver capability, along with the smooth engagement of the pump, shall be tested as follows:

(1) Fill both the water tank and the foam tank completely with water, and add dye or foam concentrate to the foam tank.
(2) With the vehicle being driven at 32.2 kph (20 mph), engage and disengage the pump(s) without damage to the pump or pump drive system.
(3) Bring the vehicle to a stop, and prepare the primary turrets and ground sweeps (or optional bumper turret) for discharging.
(4) Place the agent selector in the foam mode, and set the agent system pressure relief to relieve at the recommended pressure for optimum performance.
(5) Initiate discharge through the primary turrets and ground sweeps/bumper turret nozzles, and drive the vehicle in a forward and reverse direction at speeds ranging up to 8 kph (5 mph). Stop and start the vehicle, and change direction from forward to reverse while operating through this speed range without interrupting the discharge flow rate or range. Engage and disengage the pumps during the test.
(6) Repeat 6.4.9.3(5) both on and off the road.

6.4.9.4 During the test, there shall be no indication of proportioning, pressure, or flow rate instability.

6.4.9.5 The operation of the pump shall not cause the engine to stall.

6.4.9.6 Engagement of the pump or vehicle drive shall be accomplished without introducing any vehicle dynamics such as severe lurching.

6.4.9.7 Dye or foam solution shall be evident while discharging from all nozzles.

6.4.10* Hydrostatic Pressure Test.

6.4.10.1 Test equipment shall consist of the following:

(1) Hydraulic pressure gauge with a scale adequate for monitoring a pressure equal to 1½ times the agent system pressure of the vehicle
(2) Pressure charging device capable of developing a pressure equal to 1½ times the agent system pressure of the vehicle and sustaining it for 15 minutes or longer
(3) Miscellaneous plates or caps to isolate the tank-to-pump side of the agent system, as necessary, from the hydrostatic test pressure

6.4.10.2 The vehicle's agent system shall be fully assembled at the time of the test.

6.4.10.2.1 Because it is sometimes desirable to perform the hydrostatic pressure test before the body is completely assembled and fire-fighting system controls are in place, the agent system shall not be required to be fully operational during the hydrostatic portion of the test.

6.4.10.3 The water and foam concentrate or foam solution discharge piping shall be tested as follows:

(1) Isolate all tank-to-pump piping components that cannot tolerate the hydrostatic test pressures from the discharge piping and pump(s) by installing temporary plates or caps between these items and the discharge piping. Include the agent pumps in the test.

(2) Close all discharge nozzles and seal any bypass lines from the pressure piping to the agent tanks.
(3) Connect a pressure charging device (e.g., electric motor-driven water pump or hand pump) into the discharge piping.
(4) Activate the pressure charging device, fill the agent pumps and discharge piping with water, and pressurize to at least 1½ times the maximum recommended agent system operating pressure.
(5) Close the supply line from the pressure charging system, thereby sealing the discharge piping in a pressurized condition.
(6) Maintain the test pressure for at least 15 minutes without degradation.
(7) If leaks exist that cause the pressure to drop, repair the leaks and repeat the test.
(8) On completion of the hydrostatic test, disconnect the charging device and reassemble the tank-to-pump piping.
(9) Fill the agent tanks and piping with water, and inspect the tank-to-pump piping for leaks after the agent system has been operated in the foam mode.

6.4.10.4 No pressure decay shall be permitted during the 15-minute test.

6.4.10.5 No discharge or tank-to-pump piping water leaks shall be permitted during or after agent system operation.

6.4.11* Foam Concentration Test.

6.4.11.1 The test equipment described in NFPA 412 shall be used for this test.

6.4.11.2 Each discharge nozzle on the vehicle shall have been individually verified as discharging at a flow rate within the tolerance specified.

6.4.11.2.1 The agent system shall have been verified as capable of operating at full rate.

6.4.11.3 The test shall be conducted as follows:

(1) Fill the water and foam tank to the top and refill as necessary throughout the test.
(2) Set the foam proportioning system to proportion foams at the concentration specified, and set the agent selector for the foam mode.
(3) Set the agent system pressure relief to the recommended pressure.
(4) Engage the agent pumps and bring them up to maximum pumping speed with all discharge outlets closed.
(5) Test each foam delivery system in accordance with NFPA 412 for the individual nozzle/flow rate as follows:
    (a) Primary turret(s) full rate
    (b) Primary turret(s) half rate
    (c) Ground sweep/bumper turret
    (d) Handline nozzles
    (e) Undertruck nozzles

6.4.11.4 The foam concentrations measured shall fall within the permitted tolerances specified in NFPA 412 for each nozzle.

6.4.12* Primary Turret Flow Rate Test.

6.4.12.1 A stopwatch shall be required for this test.

6.4.12.2 The agent system shall be fully operational.

6.4.12.2.1 The agent system pressure shall be set in accordance with the manufacturer's recommendations.

6.4.12.2.2 The water tank shall be filled completely.

6.4.12.3 The test shall be conducted as follows:

(1) Simultaneously initiate discharge through the primary turret(s) at the maximum flow rate and start the stopwatch.
(2) Continue discharging until the pump cavitates, as indicated by a significant drop in discharge pressure, and stop the watch when this occurs. Record the elapsed time.
(3) Divide the rated water tank capacity, in liters (gallons), by the elapsed discharge time to determine the average discharge rate.

6.4.12.4 The average measured discharge rate shall be in agreement with the nominal discharge rate specified.

6.4.12.4.1 The total elapsed discharge time shall be no less than 1 minute nor greater than 2 minutes.

6.4.13 Piercing/Penetration Nozzle Testing.

6.4.13.1* The manufacturer shall demonstrate the ability to penetrate a sandwiched metal sample of two pieces of 0.090 5052 grade soft aluminum material with the penetration device in under 3 seconds.

6.4.13.2* The manufacturer shall demonstrate the ability to penetrate a sandwiched metal sample of two pieces of 0.090 2024–T3 grade aircraft aluminum in under 3 seconds.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 The basic NFPA recommendations on the use and provision of this equipment are contained in NFPA 402 and NFPA 403. Field testing procedures for aircraft rescue and fire-fighting vehicles utilizing foam are provided in NFPA 412.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction. The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.3 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.2 Aircraft Rescue and Fire Fighting (ARFF). Additionally, ARFF personnel will enter the aircraft to provide assistance to the extent possible in the evacuation of the occupants. Although life safety is primary to ARFF personnel, responsibilities such as fuselage integrity and salvage should be maintained to the extent possible. [**402,** 2013]

A.3.3.7 Angle of Approach. It is determined by the horizontal ground line and the line tangent to the loaded radius of the front tire extended forward to that fixed point on the vehicle that forms the smallest angle.

A.3.3.8 Angle of Departure. It is determined by the horizontal ground line and the line tangent to the loaded radius of the rear tire extended rearward to that fixed point on the vehicle that forms the smallest angle.

A.3.3.12 Bogie. In a 6 × 6 vehicle, there are two axles at the rear of the vehicle to support the weight on the rear. This two-axle combination is called a "rear bogie." With an 8 × 8 vehicle, there are two axles in the front and two axles in the rear; therefore, there is a front bogie and a rear bogie.

A.3.3.14 Center of Gravity. Where a vehicle is tipped to such a degree that a vertical line passing through the center of gravity falls on the ground outside the tire track, it is unstable and can turn over.

A.3.3.15 Complementary Agent. These agents can extinguish by means of chemical reaction, cooling, or removal of oxygen and are applied to special fire situations such as three-dimensional running fuel fires.

A.3.3.17 Cooling Preheater Device. It usually consists of a coolant jacket and an electric heating element. The engine coolant flows through the preheater jacket and is heated by the heating element, which obtains its power from an outside source, thereby maintaining the engine coolant at a constant temperature for fast starting.

A.3.3.18 Diagonal Opposite Wheel Motion. This measurement is compared diagonally — from right front to left rear wheels of the vehicle — or opposing corners of the vehicle.

A.3.3.28 Forward-Looking Infrared (FLIR). The FLIR system, which consists of FLIR camera, monitor, and controlling devices, provides the operator with an image that can be used to drive aircraft rescue and fire-fighting (ARFF) vehicles under 0/0 visibility conditions.

A.3.3.34 Intended Airport Service. See also NFPA 403 for further information concerning aircraft rescue and fire-fighting services at airports.

A.3.3.35 Interaxle Clearance Angle (Ramp Angle). It is determined by the horizontal ground line and whichever of the following lines forms the smaller angle:

(1) The line tangent to the loaded radius of the front tire extended rearward to that fixed point on the vehicle, ahead of a vertical line midway between the two axles, that determines the smallest angle
(2) The line tangent to the loaded radius of the rear tire extended forward to that fixed point on the vehicle, behind a vertical line midway between the two axles, that determines the smallest angle

A.3.3.41 Off-Pavement Performance. "Other than paved surfaces" includes dirt roads and trails and open cross-country of all kinds. This ability sometimes is referred to as off-road mobility or cross-country mobility. All of these terms are synonymous.

A.3.3.43 Overall Height, Length, and Width. These dimensions include all fixed protrusions that could in any way hinder the passage of the vehicle. Dimensions that include a movable protrusion are determined with the protrusion in its normally stored position.

A.3.3.44 Percent Grade. A change in elevation of 15.2 m (50 ft) over a horizontal distance of 15.2 m (50 ft) is equivalent to a grade of 100 percent.

A.3.3.47 Propellant Gas. Nitrogen, air, argon, and carbon dioxide are propellant gases that can be used with an agent. The quality of these gases is specified according to guidelines provided by the manufacturer of the agent. The guidelines can include moisture and dew point qualifications. During discharge, the gas provides an energy source, which aids in propelling the agent to meet its performance standards.

A.3.3.53 Rubber-Gasketed Fitting. It incorporates a rubber seal held in place by a two-piece clamp that also engages annular grooves near the end of each pipe to prevent pullout under pressure.

A.3.3.57 Steering Drive Ends. The universal joint that allows steering while transmitting power is supported by the steering drive end at its inner end, and the outer end is connected to the wheel hub through a driving flange. Steering drive ends are also known as stub shafts.

A.3.3.59.1 Driver's Enhanced Vision System (DEVS). The DEVS comprises 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; and (3) *Vision*, which allows the ARFF vehicle operator to see in 0/0 visibility conditions.

A.3.3.59.2 Electronic Stability Control System. It incorporates sensors for determining vehicle parameters as well as an electronic control unit to modulate braking and traction forces.

A.3.3.59.3 Global Positioning System (GPS). The user equipment — that is, GPS receiver — provides the user with position, velocity, and time information. Aircraft rescue and fire-fighting (ARFF) vehicle position provided by the driver's enhanced vision system (DEVS) is derived from the system's GPS receiver and displayed on the moving map display.

A.3.3.59.3.1 Differential Global Positioning System (DGPS). DGPS works on the principle that position errors will be about the same for GPS receivers operating in the same general area. If one of these receivers has an antenna positioned at a precisely known location, the error in that receiver's determined position can be computed. This position error can then be broadcast to other GPS receivers in the area and used to improve the accuracy of their position solutions. The driver's enhanced vision system (DEVS) utilizes differential GPS.

A.3.3.61.2 Axle Tread. Where dual tires and wheels are used at each end of an axle, the tread is measured as the distance between centers of the pairs of tires or wheels.

A.3.3.62.1 Extendable Turret. The operator, while at the scene of the fire, has the ability to reposition the primary turret and attachments to a location that enhances the visibility of and access to hard-to-reach areas, thus providing the opportunity to utilize fire-fighting agents most effectively.

A.3.3.62.2 Primary Turret. Extinguishing agents are discharged from ARFF vehicles in several ways depending on the fire-fighting scenarios. In order to establish common terminology in the field, the following information is provided.

A nozzle is the final piece of hardware in the extinguishing agent delivery system that disperses the extinguishing agent in a manner that effectively extinguishes the fire or serves another purpose such as provides cooling to protect a piece of equipment. A "primary turret nozzle" is one that is mounted on a turret and complies with the primary turret nozzle discharge requirements of Table 4.1.1(c) and Table 4.1.1(d). A "single agent nozzle" is one that only discharges one type of extinguishing agent such as foam or dry chemical. "Parallel multiple agent nozzles" are nozzles that are joined in parallel and discharge more than one type of extinguishing agent either together or separately. An "entrained multiple agent nozzle" is a nozzle that is designed to discharge multiple entrained fire extinguishing agents. A "piercing nozzle" is a nozzle with a point that can penetrate through the aircraft fuselage to discharge a fire extinguishing agent(s) into the interior of an aircraft.

A turret is a pivoted and revolvable device that holds the nozzle. Turrets are either primary or auxiliary depending on discharge rate and method of attack. Bumper turrets are mounted on the front bumper and are remotely operated from the cab of the vehicle. Boom turrets are mounted on articulating booms and located on the front end or top deck of the vehicle. Roof turrets are mounted on a vehicle roof and are manually or remotely operated

There are several types of booms. The "single axis boom" is remotely operated on a single axis. A "single axis extendable boom" is remotely operated and is capable of being moved on a single axis that can also be extended. A "multiple axis extendable boom" is capable of being extended and operated on both a horizontal and a vertical axis. Manufacturers of vehicles with booms should provide a diagram to the purchaser depicting the capabilities of the boom showing the side and top views of the vehicle. Figure A.3.3.62.2(a) and Figure A.3.3.62.2(b) are examples of the format that could be used.

A.3.3.63 Twenty-Five Percent Drainage Time. A method of measuring drainage time is provided in NFPA 412.

A.3.3.65 Underbody Clearance Dimensions. These dimensions include all components of the vehicle, except those that are part of the axle assemblies, that could hinder the passage of the vehicle.

A.3.3.69.1 Fully Loaded Vehicle. The crew allowance is 102 kg (225 lb) per seating position. Unless otherwise specified, the equipment allowance is 113.3 kg (250 lb) per storage compartment, up to a maximum of 453.6 kg (1000 lb). Where the customer specifications require that more equipment be carried, the actual weight of the equipment is to be included.

A.3.3.69.2 Prototype Vehicle. A given chassis, body, and fire-fighting system and fully loaded weight condition constitute a vehicle configuration. Product improvements and customer options negate previously conducted prototype tests only if they substantially affect a performance factor.

A.3.3.70 Vehicle Types. The term *wheel* in this designation is interpreted to mean either a single tire or a set of dual tires operating as one tire. The first number is the number of wheels, the second number is the number of driving wheels.

A.3.3.71 Wall-to-Wall Turning Diameter. It is, therefore, the diameter of the smallest circle that can be described by the outermost point on the vehicle as it negotiates a 360 degree turn to the right or left.

A.3.3.72 Weather Resistant. This term is not intended to describe items that are watertight or submersible.

A.4.1 The minimum size of the firehouse garage door(s) for a major fire-fighting vehicle should be at least 5.5 m (18 ft) wide by 5.5 m (18 ft) high.

When creating the response roadways from the firehouse to the incident area(s), the airport designer should consider the information in Table A.4.1(a) and Table A.4.1(b) when sizing the radius of curves. ARFF vehicles accelerate much faster than over-the-road vehicles and are very capable of obtaining higher speeds in a very short distance.

A.4.1.1 For cold weather operation where temperatures periodically fall below 0°C (32°F), some type of winterization system should be specified by the purchaser. For hot weather operation where temperatures periodically range above 43°C (110°F), some type of additional cooling system should be specified by the purchaser.

A.4.1.3 New multi-agent delivery technology systems are available that deliver multiple agents simultaneously with higher than conventional discharge pressures. These systems can also deliver agents independently at lower flow rates than a typical system. They also deliver the fire extinguishing agents in a form that improves the fire suppression performance of each agent when compared to the agents delivered in a conventional manner (for example, dry chemical suspended dry within the fire envelope, halogenated agent suspended as a vapor within the fire envelope, and foam delivered independently to minimize contamination or wetting of dry chemical to create a vapor barrier and/or further cool the fire environment). These delivery technologies are designed to improve the fire suppression capability of all agents.

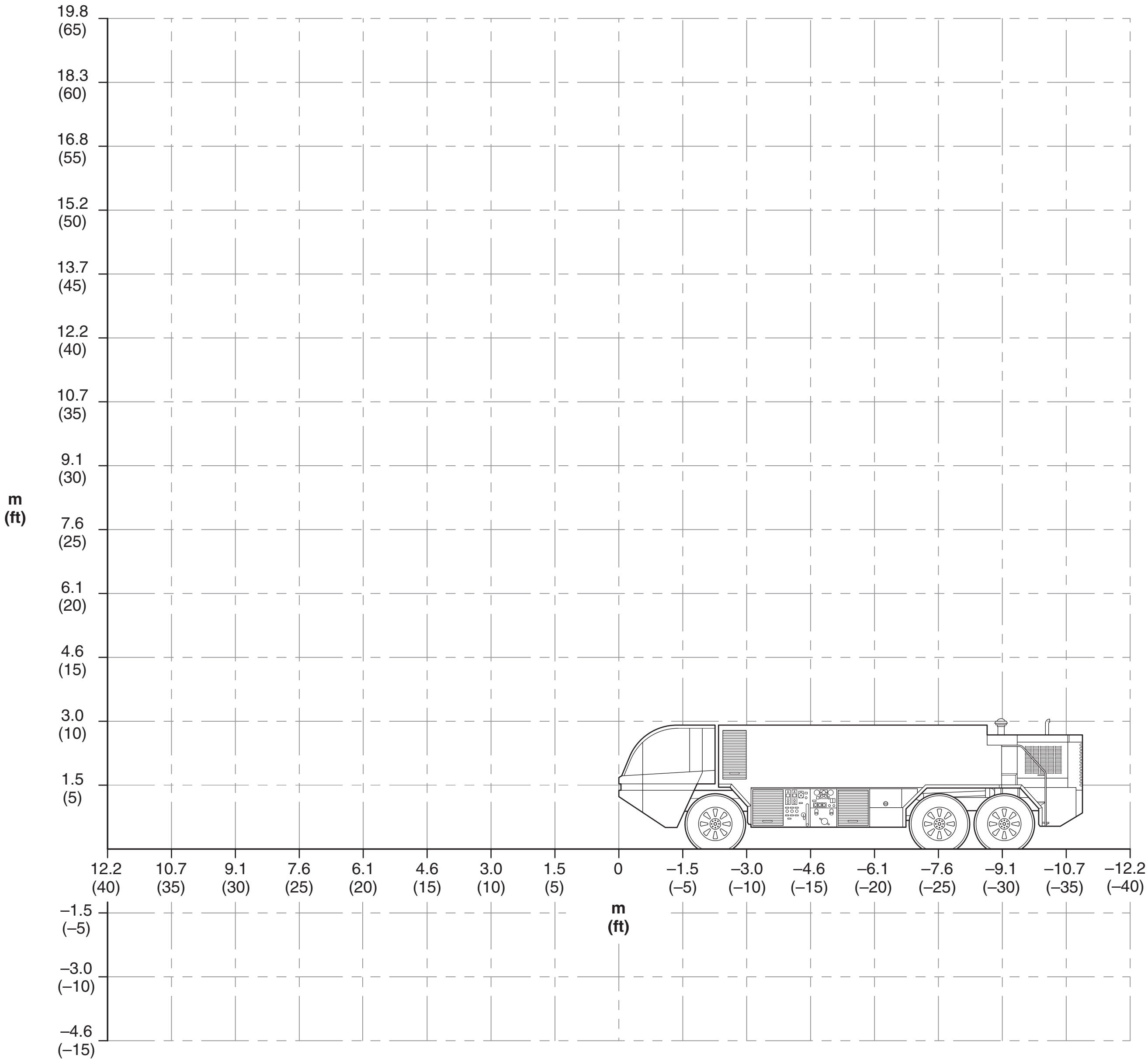

FIGURE A.3.3.62.2(a) Sample of Side View to Show Boom Capabilities.

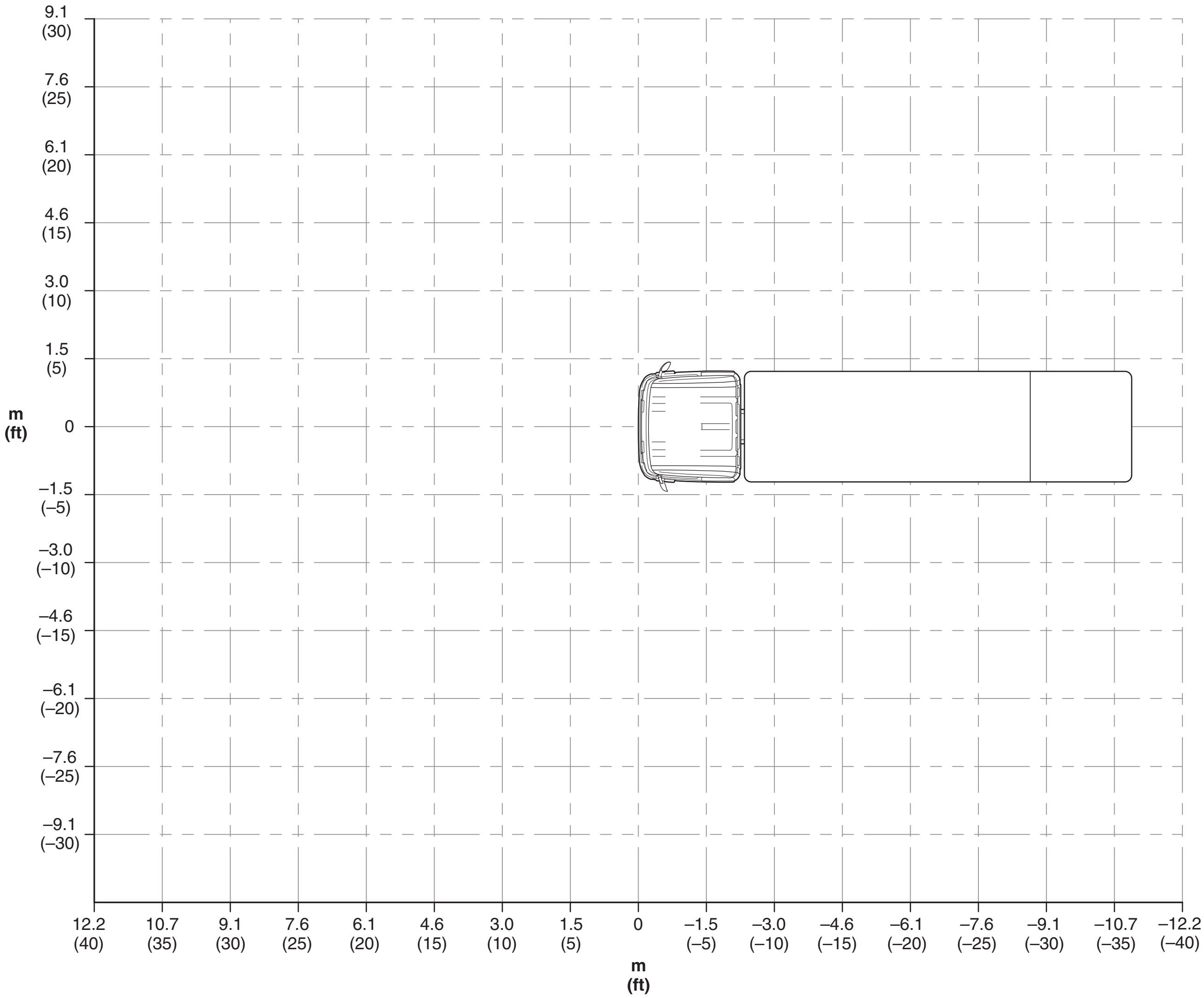

FIGURE A.3.3.62.2(b) Sample of Top View to Show Boom Capabilities.

Table A.4.1(a) Vehicle Speed over Distance from a Standing Start

Distance Traveled from a Standing Start of the Vehicle		Speed of Vehicle at the Given Distance					
		Vehicle Water Tank Capacity ≥227 to ≤1999 L (≥60 to ≤528 gal)		Vehicle Water Tank Capacity >1999 to ≤6000 L (>528 to ≤1585 gal)		Vehicle Water Tank Capacity >6000 L (>1585 gal)	
m	ft	kph	mph	kph	mph	kph	mph
30.5	100	29.0	18	32.2	20	29.0	18
76.2	250	40.2	25	48.3	30	40.2	25
152.4	500	48.3	30	64.4	40	48.3	30
228.6	750	64.4	40	72.4	45	64.4	40
304.8	1000	72.4	45	80.5	50	72.4	45

Table A.4.1(b) Minimum Radius of a Curve Based on Speed

Speed		Minimum Radius of a Curve with a 0.04 Superelevation (Almost Flat)*	
kph	mph	m	ft
32.2	20	39.6	130
48.3	30	92.0	302
64.4	40	174.6	573
80.5	50	291.1	955
88.5	55	436.5	1432
96.6	60	498.9	1637

*Values were extracted from the AASHTO publication "A Policy on Geometric Design of Highways and Streets."

A.4.1.5 The following is a list of available options that can be ordered from ARFF vehicle manufacturers:

(1) General ARFF vehicle options:
  (a) Winterization system providing sufficient insulation and heating capacity, by means of hot circulating liquids and/or forced-air exchangers, to permit satisfactory operation of the vehicle and fire-fighting systems for a period of at least 4 hours at ambient temperatures as low as −40°C (−40°F) with the vehicle fully operational and the engine running. At the end of the 4-hour period, the vehicle should be capable of successfully discharging its agent(s). The winterization system should not detract from the performance of the vehicle and fire-fighting system in ambient temperatures up to −43.5°C (−46.3°F).
  (b) Pintle-hook-type towing connection rated at 13,607 kg (30,000 lb) gross trailer weight, attached to the vehicle's frame at the rear of the vehicle
  (c) Roll-up-type compartment doors (other than service doors)
  (d) Windshield deluge system *(see 4.12.4.6)*
  (e) Training video tape covering the operation of the vehicle
  (f) Navigation system of a driver's enhanced vision system (DEVS) *(see 4.12.4.7)*
  (g) Monitoring and data acquisition system (MADAS) *(see 4.12.7)*
(2) Dimensional, safety, and stability enhancement options:
  (a) Added payload capacity (GVWR) to carry special equipment where the purchaser identifies added equipment
  (b) Increased overall width of the vehicle to facilitate increased performance and maneuverability with no concern for movement on public highway(s)
  (c) Audiovisual devices that meet or exceed the field of vision provided by wide-angle mirrors
(3) Engine(s) with related options:
  (a) Engine that operates at necessary performance above 609.6 m (2000 ft) elevation
  (b) Radiator shutters *(see 4.4.2.3.3)*
  (c) Engine coolant filter
  (d) Silicone coolant and heater hoses
  (e) Heated diesel fuel–water separator
  (f) Automatic drain(s) for the diesel fuel–water separator
  (g) Auxiliary fuel tank(s) commensurate with need to meet local requirements
  (h) Stainless steel exhaust systems and muffler(s)
(4) Vehicle electrical and lighting options:
  (a) Automatic eject-type electrical receptacles
  (b) On-board battery charger/conditioner *(see 4.5.4)*
  (c) Line voltage electrical systems in accordance with NFPA 1901, Chapter 22
  (d) High-intensity spotlight(s) on the left and right side of the windshield, hand adjustable type, with controls for beam adjustment inside the truck cab
  (e) High-intensity spotlight(s) mounted on the primary turret nozzle(s), with controls located in the cab instrument group
  (f) Two high-intensity floodlights, mounted on each side of the vehicle
  (g) Two high-intensity fog-type driving lights mounted on the front bumper
  (h) Two high-intensity driving lights mounted on the front bumper
  (i) Two high-intensity floodlights on the rear of the vehicle
  (j) Map lights on each side of the dash; a control switch on the instrument group panel in the cab for control of the lights
  (k) Rotating beacon-type lights on the top roof deck and visible for 360 degrees in the horizontal plane; a control switch on the instrument group panel in the cab for control of the light
  (l) Strobe-type light(s) on the top roof deck and visible for 360 degrees in the horizontal plane; a control switch on the instrument group panel in the cab for control of the light(s)
  (m) Fused radio electrical connection in the cab adjacent to the radio mounting location (power ratings to be provided by purchaser)
(5) Suspension, mobility, and tire options:
  (a) Reduced underaxle and underbody clearances to provide a more stable performance on pavement when the vehicle suspension is designed to permit instantaneous adjustment to the required height for off-pavement travel
  (b) Tag or other nonpowered axle(s) to assist in weight distribution and/or stability requirements
  (c) Vehicle stability systems
  (d) Passive or active suspension components to increase the stability of the vehicle while decreasing the rollover threshold
  (e) Spare tire(s)
  (f) Bead locks on tires and rims
  (g) Run-flat devices in all tires and wheels mounted on the vehicle
  (h) Rear-wheel steering system
(6) Vehicle brake options:
  (a) Air brake reservoirs drain valve(s) actuated by the driver from a location or compartment not requiring a creeper to access the actuator
  (b) Auto-eject-type connectors air connection used to change brake air tanks from an external air source
(7) Vehicle cab operating and driving options:
  (a) Tilt and telescoping steering wheel
  (b) Supplementary designated seat positions for additional crew members

(c) Quick access passage to the roof
(d) Cab air-conditioning meeting current automotive-truck and environmental protection standards for vehicle air-conditioning (acceptable pass/fail criteria not changed by the use of air-conditioning)
(e) Air-suspension-type driver [passenger(s)] seat(s), with vertical, fore, and aft adjustment
(f) Crew seat back(s), with storage of self-contained breathing apparatus (SCBA) with quick-release-type holders incorporated into the seat cushion

(8) Fire-fighting systems' options:
(a) Water tank design that allows access with each baffled compartment of the tank for internal and external inspection/service
(b) Automatic foam proportioning system, permitting use of 3 percent and 6 percent foam concentrates automatically when selected (change of proportioning plates not required)
(c) Electronic foam proportioning system
(d) Foam tank drain valve(s), drain line, and hose that facilitate draining the tank into specified container(s) positioned on the ground within 3 m (10 ft) in either horizontal direction of the foam tank drainage system
(e) Manually operated roof turret with controls located in the cab, the operation force of the controls requiring less than 134.4 N (30 ft-lb) including in-cab indicator of turret elevation and azimuth
(f) Manually operated roof turret with controls located on the cab roof platform, the operation force of the controls requiring less than 224 N (50 ft-lb)
(g) Turret controls located in the cab or on the roof platform
(h) Manual override of roof turret functions in the cab not exceeding 134.4 N (30 ft-lb) operation forces
(i) Turret(s) controls accessible both to the driver and the crew member
(j) Turret(s) equipped with an auxiliary agent discharge *(see 4.24.1)*
(k) Extendable-type primary turret *(see 4.19.6)*
(l) Color camera mounted on the extendable turret *(see 4.19.6)*
(m) Video recorder for color and/or FLIR camera(s)
(n) Aircraft skin penetrator/agent applicator mounted on the extendable turret *(see 4.19.6)*
(o) Pre-connect handlines and nozzles (water/foam/combined/auxiliary agent/mounted parallel entrained streams)
(p) Bumper turret *(see Section 4.21)*
(q) High-capacity bumper turret
(r) Two or more undertruck nozzles *(see 4.21.1 and 4.21.3)*
(s) Fire system pressure gauge/light/warning on the cab instrument panel grouping and/or on the side structural control panel
(t) Foam-liquid tank level gauge/light/warning on the cab instrument panel grouping
(u) Remote foam/water liquid level gauge/light/warning on the side panel and/or supply/service locations
(v) Bumper turret and/or ground sweep valve controls located in the cab
(w) Undertruck nozzle valve control in the cab
(x) Auxiliary agent pressurization control on the cab instrument grouping
(y) Remote mounted instrument and control panel (structural panel)

A.4.2.1 A minimum 1-year warranty should be supplied by the contractor. Purchasers should require that bids be submitted with a detailed description of the vehicles offered and drawings showing general arrangements, weights, and dimensions. Information data similar to that provided in Figure C.1 also should be required.

A.4.2.2.3.10 The parts manuals and service manuals for commercial chassis are prohibitively expensive, hard to obtain, and in some cases do not exist. If a manufacturer provides a custom-built chassis (such as those provided for a Class 4 or 5 heavy ARFF vehicle), then a complete parts and service manual must be provided for the vehicle.

A.4.3.1 The carrying capacity of a vehicle is one of the least understood features of design and one of the most important. All vehicles are designed for a maximum GVWR or maximum total weight, which should not be exceeded by the apparatus manufacturer or by the purchaser after the vehicle has been placed in service. For tractor-drawn vehicles, the in-service weight of the apparatus should not exceed the gross combination weight rating (GCWR). There are many factors that make up the rated GVWR, including the design of the springs or suspension system, the rated axle capacity, the rated tire and wheel loading, and the distribution of the weight between the front and rear wheels. [**1901:** A.12.1]

Water Tank. One of the most critical factors is the size of the water tank. Water weighs approximately 8.3 lb/gal (1 kg/L). A value of 10 lb/gal (1.2 kg/L) can be used when estimating the weight of the tank and its water, making a 500 gal (2000 L) tank and its water about 5000 lb (2400 kg). [**1901:** A.12.1]

Miscellaneous Equipment. If the finished apparatus is not to be overloaded, the purchaser should provide the contractor with the weight of equipment to be carried if it is in excess of the allowance shown in Table 12.1.2 of NFPA 1901. *(See Section 4.3 of NFPA 1901.)* [**1901:** A.12.1]

Large Compartment Capacity. Purchasers should specify the equipment to be carried on the vehicle and should work closely with the vehicle manufacturer to ensure that the compartment capacity and GVWR are sufficient to carry the intended equipment.

FAMA provides a worksheet for use by purchasers to calculate the portable equipment weight and volumetric requirements.

This volume does not include space occupied by generators, reels, air systems, ladders, hose, and so forth, that are not in the miscellaneous equipment allowance. Total equipment weight varies significantly depending on the density of the equipment and how tightly the fire department chooses to pack it.

Overloading. Overloading of the vehicle by the manufacturer through design or by the purchaser adding a great deal of equipment after the vehicle is in service will materially reduce the life of the vehicle and will undoubtedly result in increased maintenance costs, particularly with respect to transmissions, clutches, and brakes. Overloading can also seriously affect handling characteristics, making steering particularly difficult. [**1901:** A.12.1]

Underloading. Brake equipment on heavy vehicles can be sensitive to the weight distribution of the vehicle. Specifying a GVWR significantly greater than the intended in-service weight can lead to poor brake performance, chatter, and squeal. Purchasers who specify configurations with limited compartment volume on a high-capacity chassis should consult the manufacturer to ensure that a vehicle with an underloaded condition will not result. [**1901:** A.12.1]

Fire apparatus should be able to perform its intended service under adverse conditions that might require operation off paved streets or roads. Chassis components should be selected with the rigors of service in mind.

It is important to consider the need to conserve weight and space on initial response ARFF vehicles. Rapid response, acceleration, top speed, and vehicle stability are vital to the mission.

It is, therefore, preferable that tools and equipment above what is necessary to perform initial operations be transported by other means, as needed.

The purchaser should specify the particular item required for the following:

(1) One ground ladder that meets the requirements of NFPA 1931
(2) One section of hose of minimum 63.5 mm (2½ in.) diameter for tank fill
(3) Appropriate spanner wrenches for the fittings on the vehicle
(4) One hydrant wrench or other wrench necessary to activate the local water supply
(5) A SCBA meeting the requirements of NFPA 1981 and NFPA 1500 available for each assigned fire fighter
(6) Skin penetrator/agent applicator
(7) Appropriate wheel chocks
(8) 30.5 m (100 ft) of utility rope
(9) Two axes, non-wedge type
(10) Fire-resistant blanket
(11) Bolt cutters, minimum 609.6 mm (24 in.)
(12) Multipurpose, forcible entry tool
(13) Intrinsically safe handlight(s)
(14) Two harness cutting tools
(15) Hook, grab, or salvage tool
(16) First aid kit
(17) 1.8 kg (4 lb) hammer

For a detailed discussion of rescue tools, see NFPA 402.

It is important that additional features such as structural fire-fighting equipment do not interfere with the basic ability of the vehicle to perform its primary aircraft rescue and fire-fighting function. It is considered preferable to have separate vehicles for structural fire fighting equipped with the needed complement of hose and tools, since the quantity of such equipment carried on an aircraft rescue and fire-fighting vehicle needs to be limited to conserve weight and space.

A.4.3.1.2 The intent of the weight distribution requirements is to produce the most equally divided weight distribution possible across all axles and wheels. Ideally, the front axle should not be the heaviest loaded axle. It is important to realize, however, that certain customized features not covered in the major fire-fighting vehicle chapter (such as complementary agent systems) might necessitate that the 5 percent allowance for the front axle be exceeded. Where these situations occur, the vehicle manufacturer needs to be consulted to determine the final weight distribution and to confirm that none of the established component weight ratings is exceeded and that the brake performance of the vehicle still complies with this standard.

A.4.3.2.1 Although the measurement of the axle clearance is with tires inflated to highway inflation pressure, it is understood that the actual clearance in soft soil and rough terrain could be less as tires could be deflated somewhat in order to achieve better off-road mobility.

A.4.4.1.2 At higher altitudes, the performance of a vehicle can be affected due to the reduced density of the air drawn into the engine. The resulting reduction in power is more noticeable on a normally aspirated engine (e.g., non-turbo-charged).

To assess the difference in performance at higher altitudes, it is important to obtain from the manufacturer the reduced power rating of the engine at the operating altitude. From this rating, the reduced level of acceleration performance or reduced water capacity extinguishing agent can be estimated.

A.4.7 The physical characteristics of an airport can require special suspensions, such as active, passive, or semipassive, to meet required response times.

A.4.8.2 The mobility and handling characteristics of the vehicle greatly depend on tire selection. The off-pavement tractive limit of a tire is related to the strength of the soil, power available, load, number of driving wheels, tire diameter, tire deflection, contact area, and tread pattern.

To assist the purchaser in providing a site-specific tire description, the following guidelines are recommended:

(1) Facilities with hard off-pavement conditions and small snow accumulations require a low level of flotation. For these conditions the purchaser can specify tires of a relatively small diameter and narrow sectional width operating at a high inflation pressure. This configuration can be made to maximize high-speed performance and handling while the small contact area and resulting poor off-pavement performance will have little if any impact on the effectiveness of the vehicle. A typical example of this configuration is a tire of size 16.00R20 operating within a load range of 4535.9 kg to 5443.1 kg (10,000 lb to 12,000 lb) at an inflation pressure of approximately 586 kPa (85 psi).
(2) Experience has demonstrated that tires with a relatively large diameter and wide sectional width and operating at medium inflation pressure can provide a reasonable compromise between off-pavement mobility needs and on-pavement performance and handling. Tires meeting these specifications are considered to provide reasonable flotation and are suitable for many facilities where soil is not extremely soft or wet and snow accumulations are moderate. A typical example of this configuration is a tire of size 24R21 operating within a load range of 4535.9 kg to 5443.1 kg (10,000 lb to 12,000 lb) at an inflation pressure of approximately 448.2 kPa (65 psi).
(3) Where local conditions require very high flotation to traverse obstacles of deep mud, sand, or snow, the purchaser can specify an even larger tire diameter, a larger tire cross-section, a greater tire deflection, lower wheel loads, and reduced tire inflation pressure. These specifications can be made to maximize off-pavement performance, but they can also result in some degradation of high-speed performance and handling character-

istics. While such a vehicle has a higher probability of traversing difficult off-road terrain, its effectiveness should also be judged based on the longer response time needed over the paced portion of the access route. A typical example of this configuration is a tire of size 24R21 operating within a load range of 4535.9 kg to 5443.1 kg (10,000 lb to 12,000 lb) at an inflation pressure below 275.8 kPa (40 psi) with severe restrictions to top speed capability. The purchaser can also consider devices capable of providing reliable control of the tire inflation pressure while the vehicle is in motion as a means of broadening the overall performance envelope.

A.4.8.3 To optimize flotation under soft ground conditions, tires of larger diameter or width, or both, than is needed only for bearing weight should be specified. Similarly, the lowest tire pressure compatible with the high-speed performance requirements also should be specified. Vehicle and tire manufacturers should be consulted for the tread design most suitable for the specific soil composition at individual airports.

A.4.9 Recovery of the vehicle from adverse conditions should be made by attaching the vehicle to the axles.

A.4.10.1 It is customary for manufacturers of rescue and firefighting vehicles to provide a braking system based on normal commercial practice, usually connected to a recognized standard that might have legal status in worldwide territories. These standards offer certain advantages and disadvantages that can vary from one another. Operators should consider these advantages and disadvantages with respect to their particular operating conditions and legal requirements.

A.4.10.2 By preventing wheel lock-up, anti-lock braking systems (ABS) can significantly enhance driver control and vehicle stability under certain conditions. The purchaser should consider the applicability of this option.

A.4.11.3 A rear-wheel steering (RWS) system can be used on vehicles to improve the vehicle clearance circle radius and tire wear.

A.4.12.3.6 The U.S. standards developed by SAE and the United Nations ECE regulation mirror each other except that SAE J2422 requires a roof preload impact prior to the roof crush. The ECE standard was established in 1958, while the SAE standards did not add performance criteria until 2003. Both the SAE and ECE standards are viable minimum measures of cab integrity. Manufacturers may test in excess of the standards. [**1901:** A.14.3.2]

A.4.12.4.2 The illuminated instruments and backlighting should not reflect on the windshield or distract the driver/operators with a direct reflection.

A.4.12.4.6 The windshield deluge system is included to cool the windshield and to provide operator visibility during firefighting operations.

A.4.12.4.7 A detailed description of the navigation system of the DEVS is provided in Annex D. A detailed description of the low-visibility enhanced vision system is provided in Annex D.

A.4.12.4.7.2(2) Note: A duplicate or second navigation system as described in Section 4.12.4.7.1 is not required, and a duplicate or second FLIR system as described in 4.12.4.8 is not required.

A.4.12.4.8 The FLIR camera should be mounted in a position that allows a driving default position as close as possible to the horizontal and vertical fields of vision of the driver.

The onboard monitor for the FLIR camera should be mounted in a position as close as possible to the line of vision of the driver.

A.4.12.5.2 SCBA units and other equipment stored in the crew compartment can cause injuries to occupants of the compartment if they fly around the compartment as the result of an accident or other impact. Departments should check their pack and bottle weight to ensure that it does not exceed the published rating of the SCBA holder to be provided. [**1901**: A.14.1.9.1]

A.4.12.5.2(4) A new holder can be employed for each test.

A.4.12.7 The data acquisition system should be designed to accommodate ARFF-specific requirements for on- and off-road, high-shock, high-contaminant operating environments, and the extremely high-data sampling rates that are utilized to provide enough data to historically analyze an accident or incident and for enhancement of driver training and vehicle maintenance information.

A.4.12.8 Where specified, a lateral acceleration force indicator that provides both visual and audio signals and warnings to the driver should be provided. The sensitivity of the indicator should be adjustable by the fire department to account for the individual operating capabilities of different vehicles.

A.4.13.10 It is important to consider the need to conserve weight and space on initial response ARFF vehicles. Rapid response, acceleration, top speed, and vehicle stability are vital to the mission. It is, therefore, preferable that tools and equipment above what is necessary to perform initial operations be transported by other means, as needed.

Altering locations of tools and equipment should not be permitted as this action could have an effect on vehicle stability. Final mounting locations for tools and equipment should be at the discretion of the manufacturer if the tool or equipment installation could alter the stability of the vehicle.

A.4.14.3 These items could include the tanks, piping, fill troughs, and screens.

A.4.17 An around-the-pump proportioning system operates with an eductor installed between the water pump discharge and intake. A small flow of water from the water pump discharge passes through the eductor, which creates a vacuum, causing foam concentrate to be inducted and discharged into the pump intake. Around-the-pump systems are available with fixed or variable rate proportioning. Manual variable proportioning *[see Figure A.4.17(a)]* is accomplished by an operator-controlled metering valve that corresponds to a calibrated rating chart. With this system, the operator must determine flow in order to set the metering valve. Automatic variable proportioning systems *[see Figure A.4.17(b)]* rely on a flowmeter monitoring system for total solution flow and foam concentrate flow. The flow data are fed into a microprocesser that provides readout and operator control of the foam solution percentage. Around-the-pump systems are relatively inexpensive, but they have the following limitations:

(1) Water pump intake pressure cannot exceed approximately 69 kPa (10 psi).

(2) Water and foam solution cannot be discharged simultaneously from the pump. Once activated, the system produces foam solution from all open pump discharge outlets.
(3) It is difficult to match foam concentrate with the performance required.
(4) Internal components require frequent maintenance.

Premixed foam systems utilize a separate tank to contain the foam solution that has been premixed at a specific percentage. There are two types of premix systems.

Pressure-type systems use a pressure vessel for the tank and compressed gas, usually nitrogen, to propel the premixed foam solution from the discharge device. These systems are usually installed on a quick attack–type apparatus to take advantage of the instant activation feature of this type of foam system. Pressure-type premix systems *[see Figure A.4.17(c)]* have the following limitations:

(1) Fixed foam solution percentage, once the foam solution is prepared.
(2) Size and weight of the pressure vessel.
(3) Pressure limitation of the pressure vessel.
(4) System cannot be recharged while the system is in operation.

Suction-type systems use an atmospheric tank that is connected to the water pump intake. The premixed foam solution is drawn directly into the pump and discharged as required. A suction system can be created by adding the correct amount of foam concentrate to the water tank on the fire apparatus. Suction-type premix systems have the following limitations:

(1) Fixed foam solution percentage, once foam solution is prepared.
(2) Water and foam solution cannot be discharged simultaneously from the pump. Once activated, the system produces foam solution from all open pump discharge outlets.
(3) System is difficult to recharge when system is in operation.
(4) Foam concentrates must be mechanically mixed with water to create foam solution.

CAUTION: Adding foam directly to the water tank on a piece of apparatus that was not specifically designed for premix usage will cause damage to the tank, plumbing, and pump.

Balanced pressure foam proportioning systems are installed on the discharge side of the water pump. Two orifices discharge water and foam concentrate into a common ratio controller (proportioned) located in the water pump discharge. By adjusting the area of the orifices to a particular ratio, the percent of injection can be adjusted if inlet pressures are equal. The method of controlling or balancing the foam concentrate pressure with the water pressure varies with different balanced pressure system designs. The two basic methods of balancing the pressures are systems without a foam concentrate pump and systems with a concentrate pump.

Balanced pressure systems without a foam concentrate pump are referred to as “pressure proportioning systems.” *[See Figure A.4.17(d).]* These systems utilize a pressure vessel with an internal bladder to contain the foam concentrate. When in operation, water pump pressure is allowed to enter the pressure vessel and exert pressure on the internal bladder. The foam concentrate is forced out of the bladder to the foam proportioner at a pressure equal to the water pressure. These systems are easy to operate and offer fixed or variable rate proportioning. Pressure proportioning systems have the following limitations:

(1) Size and weight of the pressure vessel.
(2) Capacity of the pressure vessel.
(3) Pressure limitation of the pressure vessel.
(4) Unit cannot be recharged when the system is in operation.

A balanced pressure system with a foam concentrate pump can be one of two basic types. A “bypass” *[see Figure A.4.17(e)]* system utilizes a diaphragm valve in the concentrate pump-to-tank line that automatically controls foam pump pressure by bypassing excess foam concentrate back to the tank. A “demand” system *[see Figure A.4.17(f)]* controls the pump speed, which controls pump pressure. Balanced pressure systems have no real operating limitations except by specific design. These systems have no water intake limitations, and discharge capacity and pressure are limited only by design. Foam solution can be discharged from any water pump outlet, equipped with a proportioning device, at various percentage rates up to system design capacity. Water and foam solution can be discharged simultaneously from the water pump. Accurate foam proportioning is available over a wide range of flow and pressure. The foam concentrate pump can be used to refill the foam concentrate tank at any time, even when the system is operating.

Balanced pressure foam proportioning systems are more complex than other types of systems and generally more expensive. However, they have the following advantages:

(1) There is no water inlet pressure limitation.
(2) Discharge capacity is limited only by design.
(3) Foam solution can be discharged from any water pump outlet equipped with a proportioning device at various percentage rates up to the system design capacity.
(4) Water and foam solution can be discharged simultaneously.

Direct injection foam proportioning systems *[see Figure A.4.17(g)]* utilize a foam concentrate pump to inject foam concentrate directly into the water pump discharge. A flowmeter(s) is installed into the water pump discharge to measure the water flow rate. The flowmeter(s) signal is used by a microprocessor to control the output of the foam concentrate pump. A measurement of the foam concentrate pump output is fed back to the microprocessor to maintain the foam concentrate flow rate at the proper proportion to the water flow rate. Direct injection systems have no real operating limitations except by specific design. Water and foam solution can be discharged simultaneously from the water pump. Accurate foam proportioning is available over a wide range of flow and pressure. Direct injection systems have the following advantages:

(1) They do not introduce a pressure loss into the water pump discharge.
(2) They automatically adapt to changing water pump inlet or discharge pressure conditions.
(3) They are simple to operate.
(4) The foam concentrate can be refilled during operation.
(5) Injection rates are operator adjustable.

Compressed air–foam systems (CAFS) *[see Figure A.4.17(h)]* are a derivation of the direct injection foam proportioning system. This type of system incorporates an onboard foam agent pump and air compressor in conjunction with a water pump. The foam agent system monitors water flow with a flowmeter installed in the water pump discharge. Foam agent pump output is regulated by an agent metering control unit that provides accurate control of the foam agent percent of injection. Air injection is controlled by an air pressure regulator. Foam agent and compressed air are properly mixed by a mixer unit installed in the water pump discharge.

A.4.17.3.1 Polyvinyl chloride, epoxies, and polyesters are among the acceptable classes of resins.

A.4.18.1.1 Care should be exercised that the premixed solution is mixed to exact proportions.

A.4.18.2.1.5 Means to guide in recharging partial loads can be a suitably marked dipstick or level gauge approved for the application.

A.4.19.6 The need for a primary turret extendable to replace conventional turrets as the principal fire extinguishing agent applicator on ARFF vehicles has been recognized for over two decades. Equipment intended to provide this capability for ARFF vehicles has been developed and is operationally practical in the ARFF service environment.

The intent of the requirements of 4.19.6 is to provide minimum performance criteria so that there is no degradation in basic turret performance, while allowing individual flexibility for specific user needs. These needs can be affected by the type of aircraft being protected, the ability to access the aircraft interior, and the ability to access shielded fires.

The extendable turret can be used for primary agent application as part of a first-arriving vehicle. As such, the vehicle should be capable of applying agent quickly without the need to deploy supporting outriggers. In the future, other design features or functions might be incorporated. For example, some devices for use in accessing the interior cabin after fire knockdown might be incorporated. These devices might or might not require stabilizing devices; depending on the function of the vehicle, the time to deploy such devices might be permitted. In any event, there should be a maximum time for total deployment of the boom/tower device. A maximum of 30 seconds is recommended. The requirements do not prohibit the development of an advanced device or a unit with a different function, recognizing that the primary turret performance should not be compromised.

It is not recommended that agent be applied from a vertically extended position before knockdown of the exterior exposure fire, unless the fire cannot otherwise be accessed. Data from demonstrations of extendable turrets, plus data from earlier turret testing, suggest that AFFF discharged at a low level is the most effective technique. The extendable turret should be designed to extend below the primary level of the cab to take advantage of low-level AFFF application. Extension of the extendable turret below the cab level also should provide advantages in accessing shielded/obstructed areas, such as in wheel-well incidents and “gear down” scenarios.

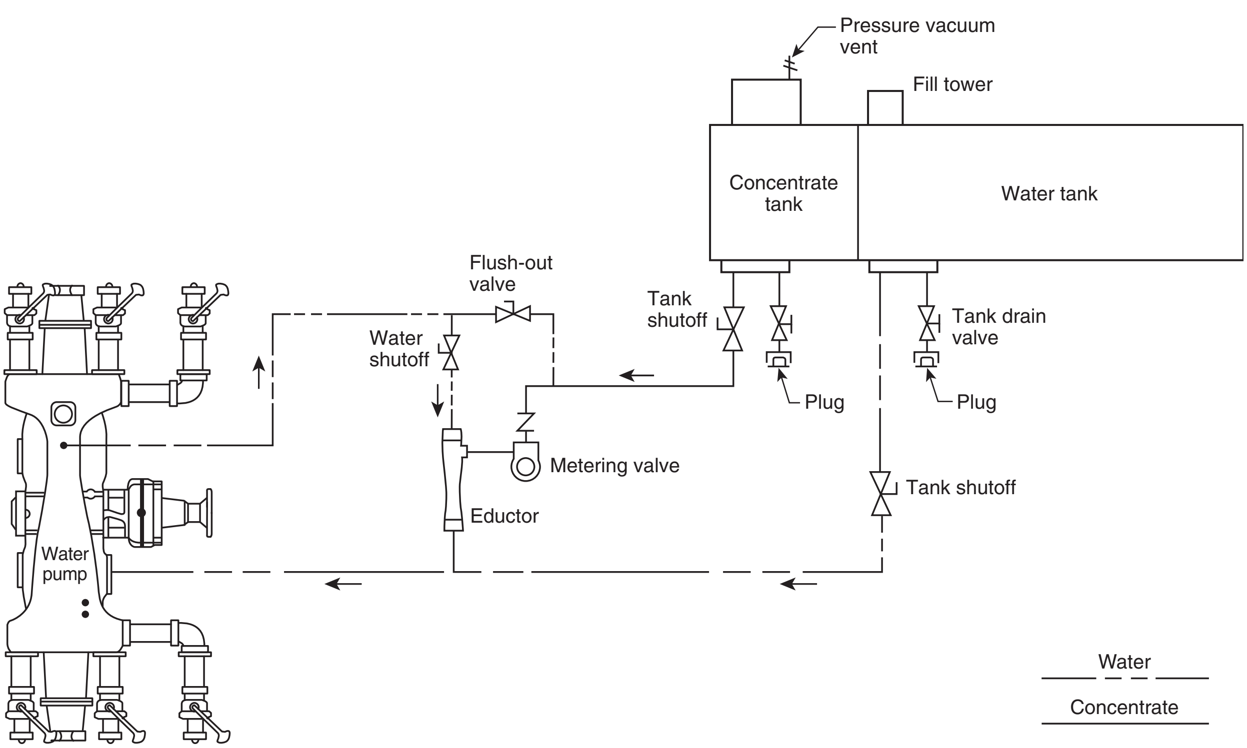

FIGURE A.4.17(a) Manual Variable Metering, Around-the-Pump Proportioning System.

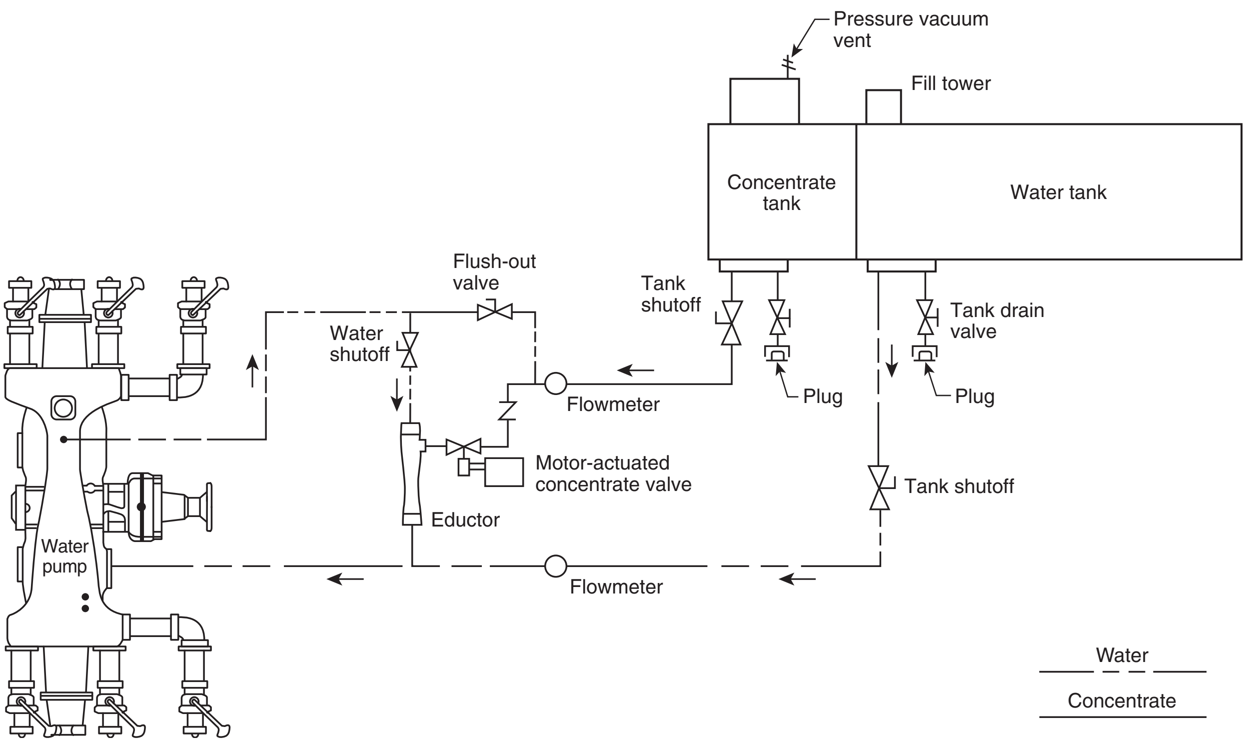

FIGURE A.4.17(b) Automatic Variable Metering, Around-the-Pump Proportioning System.

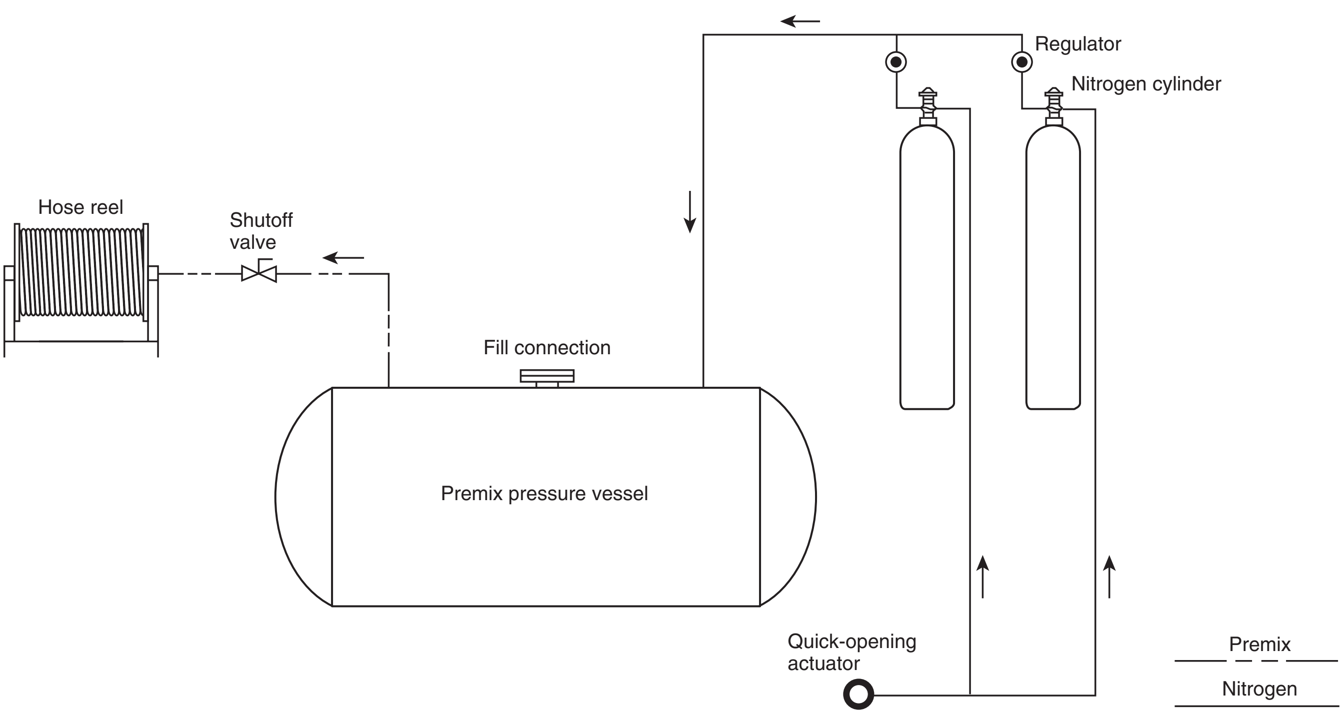

FIGURE A.4.17(c) Pressure-Type Premix System.

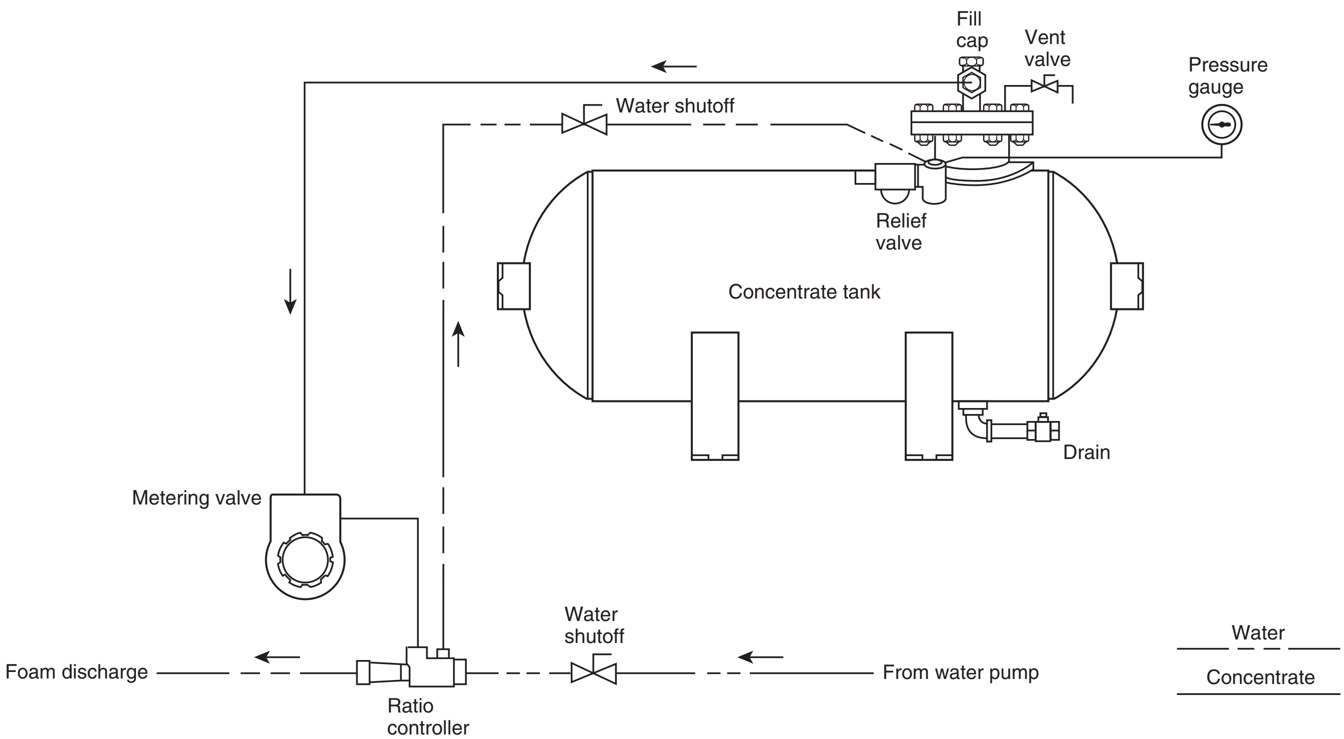

FIGURE A.4.17(d) Pressure Proportioning System.

To improve operator efficiency, the movement of the boom/tower should be accomplished with a single lever located within the cab. Elevation/azimuth indicators are not needed if the turret is in the line of sight of the operator.

Where specified, the extendable turret should be fitted with the appropriate tools/devices needed for a driver/operator to perform interior aircraft and tail-mounted engine fire-fighting functions remotely. These could include a skin penetrator/agent applicator for penetration of the fuselage to access interior fires from outside the aircraft. Where a penetrator/agent applicator is used, a minimum flow equal to two handlines (as specified in 4.17.4.3) is recommended. Airports planning to use the device for indirect attack with a skin penetrator should preplan appropriate access locations on aircraft served and the conditions under which the device is to be used.

A.4.19.6.7 The proposed concept would be to penetrate above window areas, above interior seat back height, and below baggage storage bins or through the window. Providing water extinguishment from ceiling to floor for a distance of 7.6 m (25 ft) along the fuselage left and right of the centerline of the penetration point would stop fire growth and protect the interior until other vehicles could extinguish the exterior fuel fire.

A.4.19.7 A lightweight boom-mounted turret is a primary turret mounted on a lightweight boom that is capable of being elevated and depressed to apply agent to aircraft engines, doorways, and emergency exits. Lightweight boom-mounted turrets differ from extendable turrets in that they do not need turntables. Responsive vehicle suspension, steering systems, and drive systems are used to locate the turret more directly and more rapidly.

A.4.21.1 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) can be permitted to be omitted at the option of the purchaser.

A.4.22.1.6 Where specified, the vehicle should come with a closed system to aid in reservicing the dry chemical.

A.4.23.4.7 Halogenated agents are generally incompatible with some types of seal materials.

A.4.25.1 The following are lighting options:

(1) Where specified, a spotlight on both left and right sides of the windshield, hand-adjustable type, with controls for adjustment inside the truck cab
(2) Where specified, a spotlight mounted on a turret with a control switch that is readily accessible to the operator
(3) Where specified, two high-intensity floodlights mounted one on each side of the vehicle to provide illumination of the work area adjacent to the vehicle
(4) Where specified, two high-intensity fog-type driving-type lights with a protective brush guard around each lamp and switch mounted on the dash in the cab
(5) Where specified, in addition to the normal vehicle headlight system, two high-intensity driving-type lights with a protective brush guard around each lamp and a switch mounted on the dash in the cab
(6) Where specified, two high-intensity floodlights mounted at the rear of the vehicle that are controlled by a switch in the cab
(7) Where specified, map light(s)

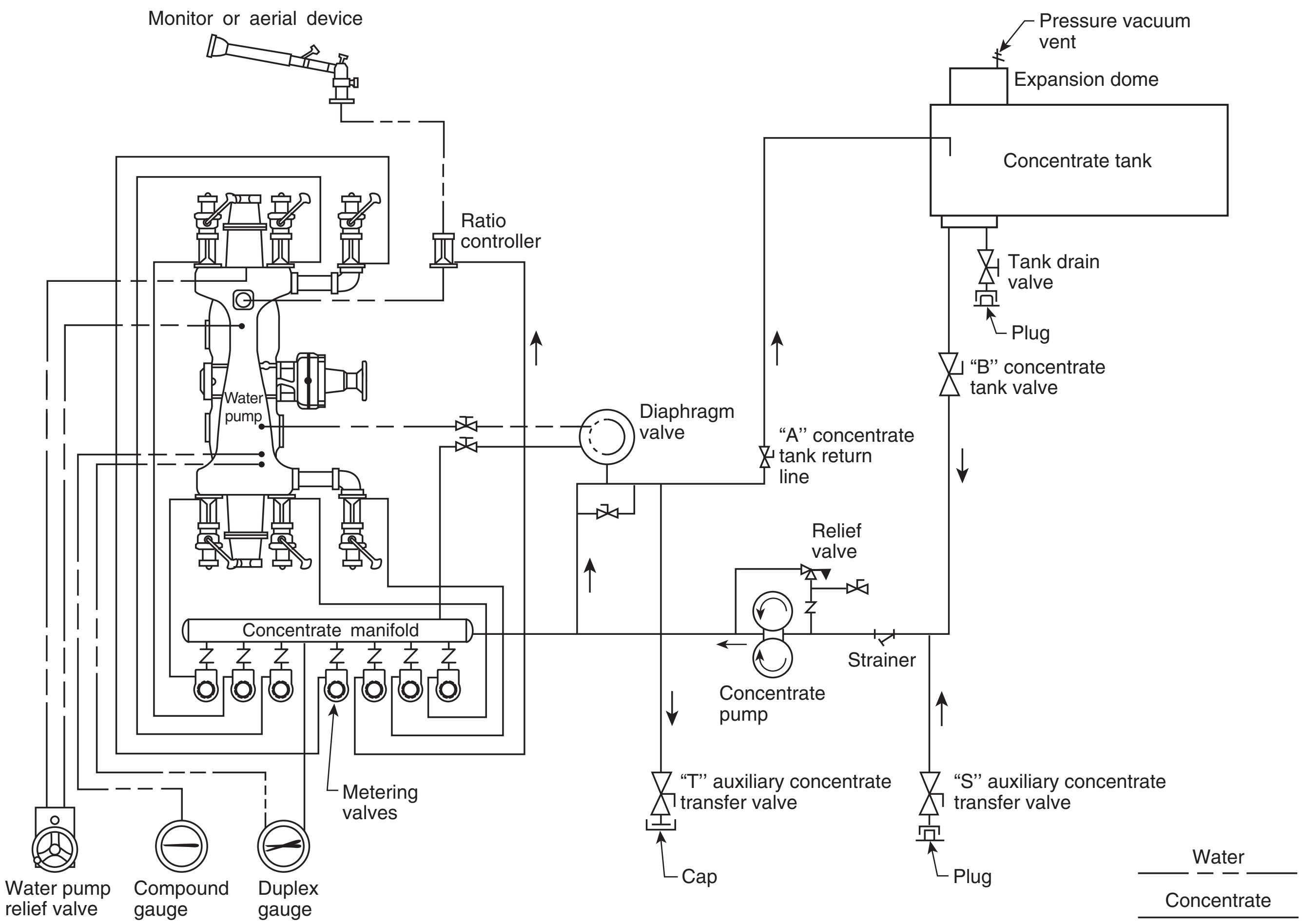

FIGURE A.4.17(e) Bypass Balanced Pressure Proportioning System.

A.4.25.2 If desired, the driver's siren control can be wired for selective control on the steering wheel horn button. If a combination public address–type siren is desired, an electronic type having an equivalent sound output should be substituted.

A.5.2.3(4) A new holder can be employed for each test.

A.5.4.1 Airports that accommodate second-level aircraft, such as the Boeing 747 and Airbus A380, operating on their airport should have a vehicle that can access the upper level aircraft door sills from ground level.

A.5.4.2 Other means than a ladder (i.e., ramp or stairway) is more easily traversed by ARFFs in full PPE carrying equipment and/or an incapacitated victim.

A.5.5.1 The Type A aircraft door is a floor-level exit with a rectangular opening of not less than 1067 mm (42 in.) wide by 1829 mm (72 in.) high, with corner radii not greater than 178 mm (7 in.).

A.5.5.2 The docking platform should have protective railings that are designed to extend after the platform is docked to prevent the presence of voids between the railings and the aircraft fuselage. Other protective panels/intermediate rails paralleling the stairs/ramp and platform should be no more than 250 mm (10 in.) apart.

A.5.6.2 The required turning radius allows for maneuverability through a crash site debris field, in the vicinity of aircraft passenger gates, and if necessary a quick reposition of the vehicle. The driver of the vehicle should have full view of the contact portion of the docking platform(s). The vehicle control should be possible at speeds less than 1.6 kph (1 mph) without noticeable lurching.

A.5.6.4 If available, active suspension, self-leveling devices, and/or vehicle stabilizers can be used for this test.

A.5.8.1 Refer to SAE ARP 1328B.

A.6.3.1 Test facilities should consist of an open site suitable for discharging agent that includes both level ground and measured grades of at least 20 percent and 30 percent. Access to a refill water supply should be required.

A.6.3.2 Test facilities should consist of a level site having a dry, paved surface at least 76.2 m (250 ft) in diameter that is free from loose material upon which a circle with a radius of 30.5 m (100 ft) should be marked in a manner that can be followed easily by a driver.

A.6.3.3 Test facilities should consist of a flat measurement pad that is large enough to accommodate the entire vehicle.

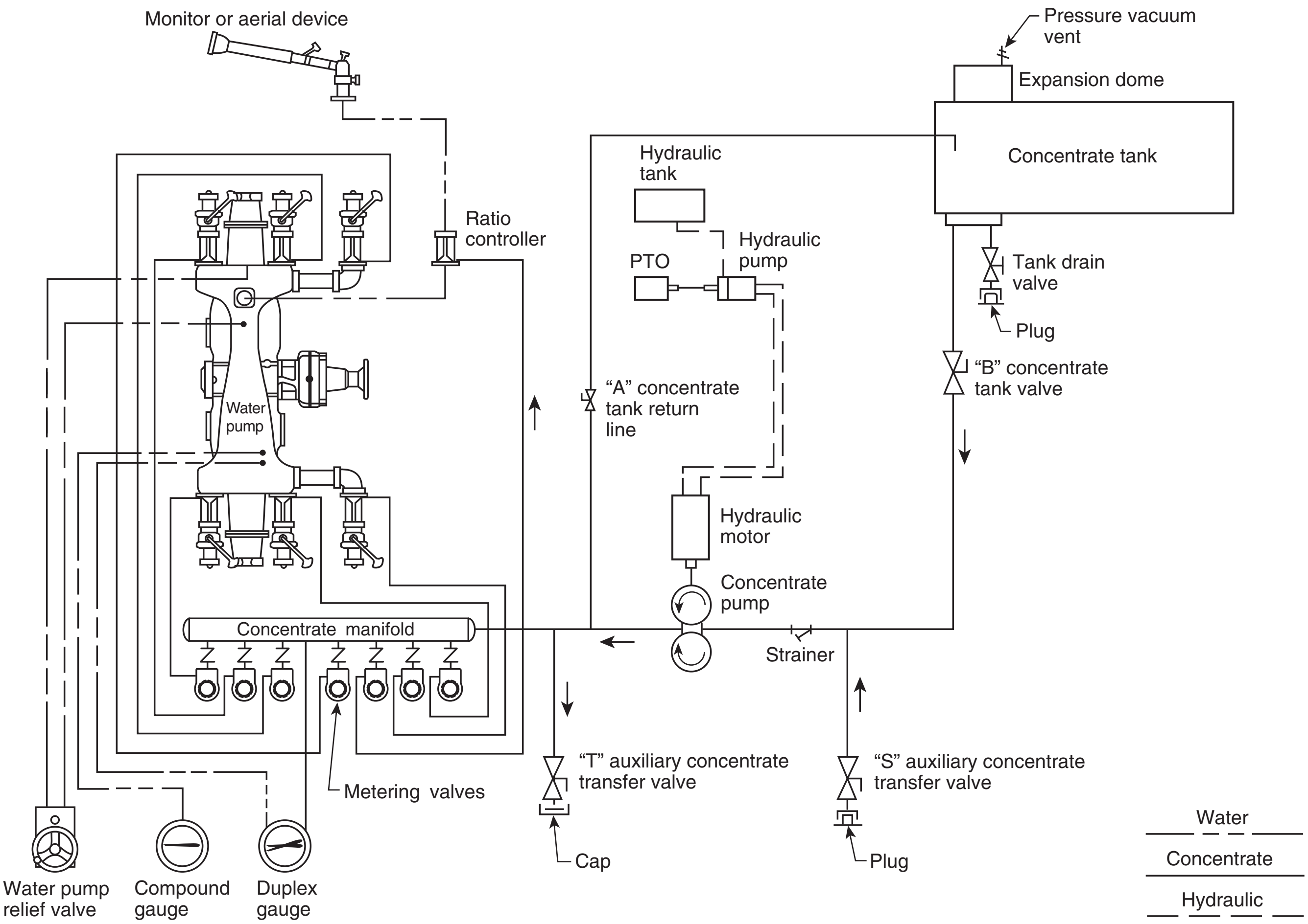

FIGURE A.4.17(f) Demand Balanced Pressure Proportioning System.

A.6.3.4 Test facilities should consist of a level site at least 6.1 m (20 ft) longer than the vehicle.

A.6.3.5 Test facilities should consist of a site suitable for discharging the agent that includes a measured grade of 40 percent at least twice the vehicle's length or a level, paved test pad adequate for an extended drawbar pull.

A.6.3.6 Test facilities should consist of an area suitable for running the engine while the electric loads and charging rates are being measured.

A.6.3.6.3.3.1 The purchaser might wish to have the entire low voltage electrical system and warning device system certified by an independent third-party certification organization. [**1901:**A. 13.14.1]

A.6.3.7 Test facilities should be in accordance with SAE J551/1 or the equivalent standard being used.

A.6.3.8 Test facilities should consist of a site that includes a measured grade of 50 percent at least equal to the vehicle in length or a level, paved test pad adequate for an extended drawbar pull.

A.6.3.9 Test facilities should consist of a flat test pad suitable for discharging agent and securing portable ramps under the vehicle.

A.6.3.10 Test facilities should consist of any dry, smooth, level, paved surface adequate in length to reach the respective test speeds and stop safely. The test area should be marked so that a lane equivalent in width to that of the vehicle plus 1.2 m (4 ft) is established.

A.6.3.11 Test facilities should consist of dry, smooth, measured grades of 20 percent and 50 percent at least equal to the vehicle in length or a level, paved test pad adequate for an extended drawbar pull.

A.6.3.12 Test facilities should consist of any dry, level, paved surface that is free from loose material.

A.6.3.13 Test facilities should consist of a level site having a dry, paved surface greater than three times the vehicle's length in diameter and free from loose material.

A.6.3.14 Test facilities should consist of a level, open site suitable for discharging agent and with access to a refill water supply.

A.6.3.15 Test facilities should consist of a level site with pumping or hydrant capacity, or both, sufficient to provide the water delivery rate needed to fill the water tank in 2 minutes at an inlet pressure of 551.6 kPa (80 psi).

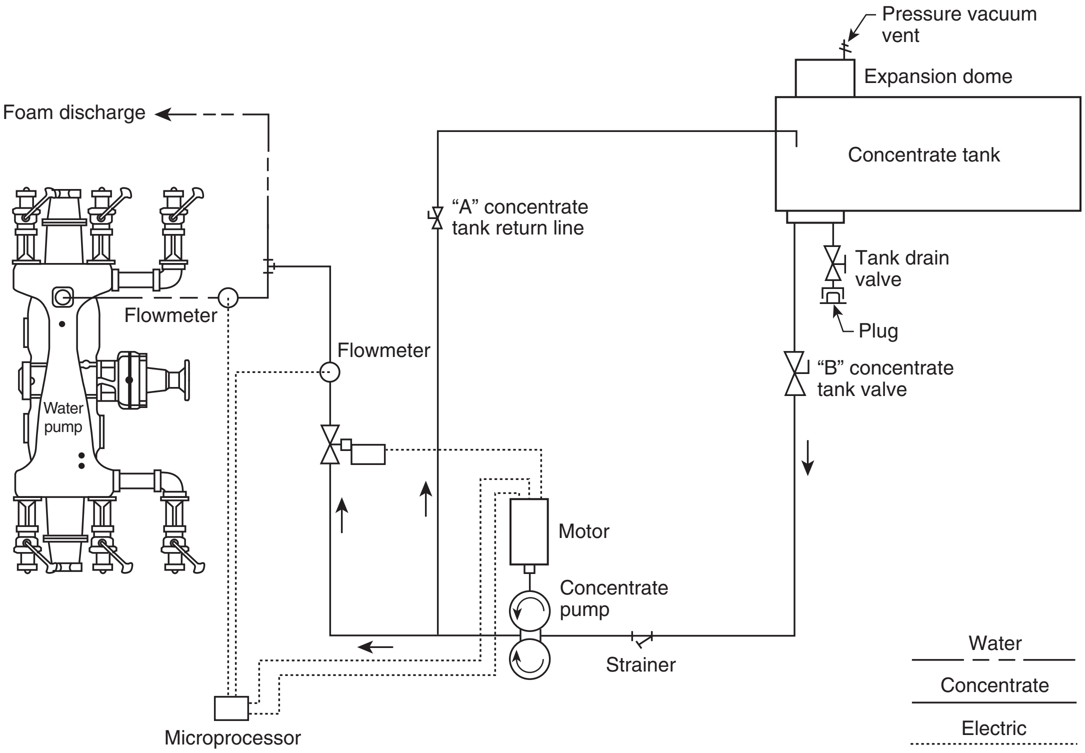

FIGURE A.4.17(g) Direct Injection Foam Proportioning System.

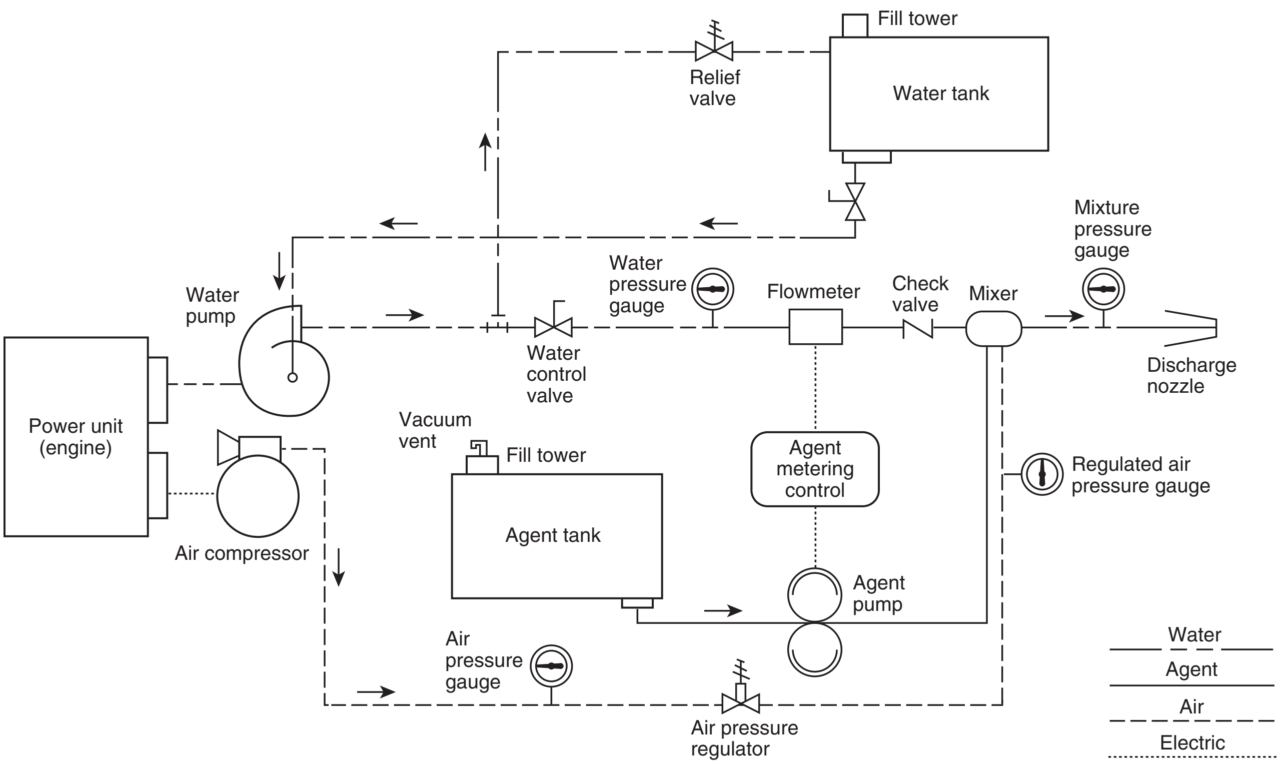

FIGURE A.4.17(h) Compressed Air–Foam System.

A.6.3.16 Test facilities should consist of an open site suitable for discharging agent and draining the vehicle and with access to a refill water supply.

A.6.3.17 Test facilities should consist of a level, open site suitable for discharging agent and with access to a refill water supply.

A.6.3.19 Test facilities should consist of a level, open site suitable for discharging agent and with access to a refill water supply.

A.6.3.20 Test facilities should consist of a level, open site suitable for discharging agent and with access to a refill water supply.

A.6.3.21 Test facilities should consist of a level, open site suitable for discharging agent and with access to a refill water supply.

A.6.3.23 Test facilities should consist of an open site suitable for discharging agent and with access to a refill water supply.

A.6.3.25 Test facilities should consist of an open site suitable for discharging agent.

A.6.3.26 Test facilities should consist of an open site suitable for discharging agent and with access to a refill water supply and a foam concentrate supply.

A.6.3.27 Test facilities should consist of a flat, open area that is free from large reflecting surfaces (such as other vehicles, signboards, or hills) within a 61 m (200 ft) radius of the vehicle.

A.6.3.28 Test facilities should consist of an open site suitable for discharging AFFF concentrate, dry chemical, or halogenated agent.

A.6.3.29 Test facilities should consist of an open site suitable for discharging the AFFF solution, dry chemical, or halogenated agent.

A.6.3.30 Test facilities should consist of a level, open site suitable for discharging the agent and measuring ranges.

A.6.3.31 Test facilities should consist of an open site suitable for discharging AFFF solution, dry chemical, or halogenated agent.

A.6.3.32 Test facilities should consist of a level, open site suitable for discharging the dry chemical or halogenated agent and measuring ranges. Wind conditions should be calm [less than 8 kph (5 mph)].

A.6.3.33 Test facilities should consist of a level, open site suitable for discharging the agent and measuring range. The test should be conducted in calm wind [less than 8 kph (5 mph)].

A.6.3.34 Test facilities should consist of a flat, open, paved area suitable for operating the vehicle at a constant speed of 80.5 kph (50 mph) and free from large reflecting surfaces (such as other vehicles, signboards, or hills) within a 15.2 m (50 ft) distance of the vehicle. The wind speed should not exceed 24.1 kph (15 mph) during the test.

A.6.4 Due to the high tilt-table angle that is required in this standard per SAE J2180, testing to 30 degree tilt angle, vehicle slipping on the table surface can occur. Research has shown that an "open grid deck" product specified as follows resists vehicle traction slippage without impacting the tilt-table angle achieved: IKG Greulich 5 in., 4-way, standard open steel grid with 4183# main bars @ 645 mm (7.5 in.) on center, 6.35 mm × 50.8 mm (¼ in. × 2 in.) crossbars @ 95.3 mm (3.75 in.) on center, on 6.35 mm × 25.4 mm (¼ in. × 1 in.) diagonal and supplemental bars.

This product is available from IKG Industries, Harsco Company, P.O. Box 100930, 860 Visco Drive, Nashville, TN 37224-0930; (615)782-4794; (800)467-2346; fax: (615)256-7881.

A.6.4.2 Test facilities should consist of an in-ground, certified weight scale large enough to accommodate the vehicle or a level test pad for positioning the truck on top of portable wheel scales.

A.6.4.3 Test facilities should consist of a dry, straight, level paved surface sufficient in length to accelerate the vehicle from rest to 80.5 kph (50 mph) and then bring it to a safe stop.

A.6.4.4 Test facilities should consist of a dry, paved, level surface suitable for achieving a vehicle speed of at least 104.6 kph (65 mph) and bringing the vehicle to a safe stop.

A.6.4.5 Test facilities should consist of a dry, smooth, paved surface adequate in length to reach the respective test speeds and stop safely. The test area should be marked so that a lane that equals the width of the vehicle plus 1.2 m (4 ft) is established. A runway or taxiway with a marked centerline should be permitted to be used.

A.6.4.7 Test facilities should consist of an open site suitable for discharging agent.

A.6.4.8 Test facilities should consist of an open site suitable for discharging agent.

A.6.4.9 Test facilities should consist of an open site suitable for discharging agent and operating the vehicle up to its maximum speed.

A.6.4.10 Test facilities should consist of an appropriate area in the vehicle manufacturer's plant.

A.6.4.11 Test facilities should consist of an open site suitable for discharging agent and with access to a refill water supply and foam concentrate supply.

A.6.4.12 Test facilities should consist of a level, open site suitable for discharging agent.

A.6.4.13.1 This demonstration need not have the penetration device mounted to the finished boom system. This demonstration is a laboratory test to show that the manufacturer understands the requirements of the penetration task requirement.

A.6.4.13.2 This demonstration need not have the penetration device mounted to the finished boom system. This demonstration is a laboratory test to show that the manufacturer understands the requirements of the penetration task requirement.

Annex B Line Voltage Electrical Systems

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

The following material is extracted from Chapter 22 of the 2009 edition of NFPA 1901 and is included here as a convenience for users of this standard.

B.1 Application. Where any part of a line voltage electrical system is provided as a fixed installation, the applicable requirements of this chapter shall apply. [**1901:**22.1]

B.2 General Requirements. [1901:22.2]

B.2.1 Stability. [1901:22.2.1]

B.2.1.1 Any fixed line voltage power source producing alternating current (ac) shall produce electric power at 60 Hz ±3 Hz when producing power at all levels between no load and full rated power. [**1901:**22.2.1.1]

B.2.1.2 Any fixed line voltage power source shall produce electric power at the rated voltage ±10 percent when producing power at all levels between no load and full rated power. [**1901:**22.2.1.2]

B.2.2 The maximum voltage supplied to portable equipment shall not exceed 275 volts to ground. Higher voltage shall be permitted only when used to operate fixed wired, permanently mounted equipment on the apparatus. [**1901:**22.2.2]

B.2.3 Conformance with *National Electrical Code* ®. [1901:22.2.3]

B.2.3.1 All components, equipment, and installation procedures shall conform to *NFPA 70* except where superseded by the requirements of this chapter. [**1901:**22.2.3.1]

B.2.3.2 Where the requirements of this chapter differ from those in *NFPA 70* , the requirements in this chapter shall apply. [**1901:**22.2.3.2]

B.2.4 When available, line voltage electrical system equipment and materials included on the apparatus shall be listed and used only in the manner for which they have been listed. [**1901:**22.2.4]

B.2.5 All equipment and materials shall be installed in accordance with the manufacturer's instructions. [**1901:**22.2.5]

B.2.6 Location Ratings. [1901:22.2.6]

B.2.6.1 Any equipment used in a dry location shall be listed for dry locations. [**1901:**22.2.6.1]

B.2.6.2 Any equipment used in a wet location shall be listed for wet locations. [**1901:**22.2.6.2]

B.2.6.3 Any equipment, except a PTO-driven generator, used in an underbody or underchassis location that is subject to road spray shall be either listed as Type 4 or mounted in an enclosure that is listed as Type 4. [**1901:**22.2.6.3]

B.2.6.4 If a PTO-driven generator is located in an underbody or underchassis location, the installation shall include a shield to prevent road spray from splashing directly on the generator. [**1901:**22.2.6.4]

B.3 Grounding and Bonding. [1901:22.3]

B.3.1 Grounding. Grounding shall be in accordance with Section 250.34(A) and 250.34(B) of *NFPA 70* . [**1901:**22.3.1]

B.3.1.1 Ungrounded systems shall not be used. [**1901:**22.3.1.1]

B.3.1.2 Only stranded or braided copper conductors shall be used for grounding and bonding. [**1901:**22.3.1.2]

B.3.1.3 The grounded current-carrying conductor (neutral) shall be insulated from the equipment-grounding conductors and from the equipment enclosures and other grounded parts. [**1901:**22.3.1.3]

B.3.1.4 The neutral conductor shall be colored white or gray in accordance with 200.6, "Means of Identifying Grounded Conductors," of *NFPA 70* . [**1901:**22.3.1.4]

B.3.1.5 Any bonding screws, straps, or buses in the distribution panelboard or in other system components between the neutral and equipment-grounding conductor shall be removed and discarded. [**1901:**22.3.1.5]

B.3.2 Bonding. [1901:22.3.2]

B.3.2.1 The neutral conductor of the power source shall be bonded to the vehicle frame. [**1901:**22.3.2.1]

B.3.2.2 The neutral bonding connection shall occur only at the power source. [**1901:**22.3.2.2]

B.3.2.3 In addition to the bonding required for the low-voltage return current, each body and each driving or crew compartment enclosure shall be bonded to the vehicle frame by a copper conductor. [**1901:**22.3.2.3]

B.3.2.3.1 The conductor shall have a minimum amperage rating, as defined in Section 310.15, "Ampacities for Conductors Rated 0–2000 Volts," of *NFPA 70* , of 115 percent of the rated amperage on the power source specification label. [**1901:**22.3.2.3.1]

B.3.2.3.2 A single conductor that is sized to meet the low voltage and line voltage requirements shall be permitted to be used. [**1901:**22.3.2.3.2]

B.3.3 Ground Fault Circuit Interrupters. [1901:22.3.3]

B.3.3.1 In special service vehicles incorporating a lavatory, sink, toilet, shower, or tub, 120 V, 15 or 20 A receptacles within 6 ft (1.8 m) of these fixtures shall have ground fault circuit interrupter (GFCI) protection. [**1901:**22.3.3.1]

B.3.3.2 GFCIs integrated into outlets or circuit breakers or as stand-alone devices shall be permitted to be used in situations other than those described in B.3.3.1. [**1901:**22.3.3.2]

B.4 Power Source General Requirements. The following requirements in B.4.1 through B.4.10 shall apply to all line voltage power sources. [**1901:**22.4]

B.4.1 All power source system mechanical and electrical components shall be sized to support the continuous duty nameplate rating of the power source. [**1901:**22.4.1]

B.4.2 The power source shall be shielded from contamination that would prevent the power source from operating within its design specifications. [**1901:**22.4.2]

B.4.3 Power Source Rating. [1901:22.4.3]

B.4.3.1 For power sources of 8 kW or larger, the power source manufacturer shall declare the continuous duty rating that the power source can provide when installed on fire apparatus according to the manufacturer's instructions and run at 120°F (49°C) air intake temperature at 2000 ft (600 m) above sea level. [**1901:**22.4.3.1]

B.4.3.2 The rating on the power source specification label shall not exceed the declared rating from the power source manufacturer. [**1901:**22.4.3.2]

B.4.4 Access shall be provided to permit both routine maintenance and removal of the power source for major servicing. [**1901:**22.4.4]

B.4.5 The power source shall be located such that neither it nor its mounting brackets interfere with the routine maintenance of the fire apparatus. [**1901:**22.4.5]

B.4.6 Instrumentation. [1901:22.4.6]

B.4.6.1 If the power source is rated at less than 3 kW, a “Power On” indicator shall be provided. [**1901:**22.4.6.1]

B.4.6.2 If the power source is rated at 3 kW or more but less than 8 kW, a voltmeter shall be provided. [**1901:**22.4.6.2]

B.4.6.3 If the power source is rated at 8 kW or more, the following instrumentation shall be provided at an operator's panel:

(1) Voltmeter
(2) Current meters for each ungrounded leg
(3) Frequency (Hz) meter
(4) Power source hourmeter

[**1901:**22.4.6.3]

B.4.6.4 The instrumentation shall be permanently mounted at an operator's panel. [**1901:**22.4.6.4]

B.4.6.4.1 The instruments shall be located in a plane facing the operator. [**1901:**22.4.6.4.1]

B.4.6.4.2 Gauges, switches, or other instruments on this panel shall each have a label to indicate their function. [**1901:**22.4.6.4.2]

B.4.6.4.3 The instruments and other line voltage equipment and controls shall be protected from mechanical damage and not obstructed by tool mounting or equipment storage. [**1901:**22.4.6.4.3]

B.4.7 An instruction plate(s) that provides the operator with the essential power source operating instructions, including the power-up and power-down sequence, shall be permanently attached to the apparatus at any point where such operations can take place. [**1901:**22.4.7]

B.4.8 Operation. [1901:22.4.8]

B.4.8.1 Provisions shall be made for placing the generator drive system in operation using controls and switches that are identified and within convenient reach of the operator. [**1901:**22.4.8.1]

B.4.8.2 Where the generator is driven by the chassis engine and engine compression brakes or engine exhaust brakes are furnished, they shall be automatically disengaged for generator operations. [**1901:**22.4.8.2]

B.4.8.3 Any control device used in the generator system power train between the engine and the generator shall be equipped with a means to prevent unintentional movement of the control device from its set position in the power generation mode. [**1901:**22.4.8.3]

B.4.9 If there is permanent wiring on the apparatus that is designed to be connected to the power source, a power source specification label that is permanently attached to the apparatus at the operator's control station shall provide the operator with the information detailed in Figure B.4.9. [**1901:**22.4.9]

Power Source Specifications

Operational Category	Continuous Duty Rating
Rated voltage(s) and type (ac or dc)	
Phase	
Rated frequency	
Rated amperage	
Continuous rated watts	
Power source engine speed	

FIGURE B.4.9 Power Source Specifications Label. [1901:Figure 22.4.9]

B.4.10 The power source, at any load, shall not produce a noise level that exceeds 90 dBA in any driving compartment, crew compartment, or onboard command area with windows and doors closed, or at any operator's station on the apparatus. [**1901:**22.4.10]

B.5 Power Source Type Specific Requirements. [1901:22.5]

B.5.1 Direct Drive (PTO) Generators. If the generator is driven by any type of PTO, it shall meet the requirements of B.5.1.1 through B.5.1.5. [**1901:**22.5.1]

B.5.1.1 The transmission's PTO port and PTO, or the split shaft PTO, and all associated drive shaft components shall be rated to support the continuous duty torque requirements of the generator's continuous duty rating as stated on the power source nameplate. [**1901:**22.5.1.1]

B.5.1.2 Where the generator is driven by the chassis engine and transmission through a split shaft PTO, the driving compartment speedometer shall register when the generator drive system is engaged. [**1901:**22.5.1.2]

B.5.1.3 Where the generator is driven by the chassis engine and transmission through a split shaft PTO and a chassis transmission retarder is furnished, it shall be automatically disengaged for generator operations. [**1901:**22.5.1.3]

B.5.1.4 The direct drive generator shall be mounted so that it does not change the ramp breakover angle, angle of departure, or angle of approach as defined by other components, and it shall not extend into the ground clearance area. [**1901:**22.5.1.4]

B.5.1.5 The direct drive generator shall be mounted away from exhaust and muffler areas or provided with a heat shield to reduce operating temperatures in the generator area. [**1901:**22.5.1.5]

B.5.2 Hydraulically Driven Generators. If the generator is driven using hydraulic components, it shall meet the requirements of B.5.2.1 through B.5.2.5. [**1901:**22.5.2]

B.5.2.1 The means can be a mechanical, hydraulic, or electronic device. [**1901:**22.5.2.1]

B.5.2.2 If the hydraulic generator system is not capable of output as stated on the power source specification label at all engine speeds, an automatic engine speed control system shall be provided. [**1901:**22.5.2.2]

B.5.2.3 If the apparatus is equipped with a fire pump driven by the chassis engine, the generator shall be capable of output as stated on the power source specification label with the engine at idle. [**1901:**22.5.2.3]

B.5.2.4 Hydraulic Components. [1901:22.5.2.4]

B.5.2.4.1 A hydraulic system filter and strainer shall be provided and shall be located in a readily accessible area. [**1901:**22.5.2.4.1]

B.5.2.4.2 Hydraulic hose shall meet the hydraulic pump manufacturer's recommendations for pressure, size, vacuum, and abrasion resistance. [**1901:**22.5.2.4.2]

B.5.2.4.3 Hydraulic fittings shall meet the hydraulic pump manufacturer's recommendations for pressure, size, and the type of hose used. [**1901:**22.5.2.4.3]

B.5.2.5 Where the hydraulic hose comes into contact with other surfaces, the hose shall be protected from chafing. [**1901:**22.5.2.5]

B.5.3 Fixed Auxiliary Engine–Driven Generators. If the generator is driven by a fixed auxiliary engine, it shall meet the requirements of B.5.3.1 through B.5.3.9.4. [**1901:**22.5.3]

B.5.3.1 The generator shall be installed so that fumes, vapors, heat, and vibrations do not enter the driving or crew compartment. [**1901:**22.5.3.1]

B.5.3.2 Generators rated at 8 kW or more shall be equipped with a high-temperature automatic shutdown system and a low-oil (pressure or level) automatic shutdown system. [**1901:**22.5.3.2]

B.5.3.3 The generator shall be installed in accordance with the generator manufacturer's requirements for ventilation and service accessibility. [**1901:**22.5.3.3]

B.5.3.4 If the generator is installed in a compartment and the compartment doors must be open during its operation, the generator shall be equipped with an interlock system to prevent its operation if the doors are not open, or the compartment shall be equipped with a high temperature alarm. [**1901:**22.5.3.4]

B.5.3.5 If the generator is installed in a compartment on a slide tray and the slide tray must be in the extended or out of position during operation, an interlock shall be provided to prevent operation unless the tray is in the correct position, or the compartment shall be equipped with a high-temperature alarm. [**1901:**22.5.3.5]

B.5.3.6 Permanently installed generators shall have readily accessible engine oil drain provisions or piping to a remote location for oil changing. [**1901:**22.5.3.6]

B.5.3.7 If the generator is located in a position on the apparatus where the operator cannot see the instrumentation and operate the controls while standing at ground level or positioned at a specifically designated operator station, an operating panel with the required instrumentation, start and stop controls, and other controls necessary for safe operation shall be provided at a remote operator's panel. [**1901:**22.5.3.7]

B.5.3.8 Fuel Systems. [1901:22.5.3.8]

B.5.3.8.1 Fuel lines shall be protected from chafing at all wear points. [**1901:**22.5.3.8.1]

B.5.3.8.2 If the fuel source is shared with the apparatus engine, a separate fuel pickup system shall be provided that is arranged to ensure that the generator cannot utilize more than 75 percent of the fuel tank's capacity. [**1901:**22.5.3.8.2]

B.5.3.9 Exhaust System. [1901:22.5.3.9]

B.5.3.9.1 The exhaust piping and discharge shall be located or shielded to prevent thermal damage to the apparatus or equipment. [**1901:**22.5.3.9.1]

B.5.3.9.2 The exhaust shall be piped to the exterior of the vehicle and discharged at a location away from any operator's position. [**1901:**22.5.3.9.2]

B.5.3.9.3 Where parts of the exhaust system are exposed so that they can cause injury to operating personnel, protective guards shall be provided. [**1901:**22.5.3.9.3]

B.5.3.9.4 Silencing devices shall be provided and shall not create exhaust backpressure that exceeds the limits specified by the engine manufacturer. [**1901:**22.5.3.9.4]

B.5.4 Belt-Driven Power Sources. If the power source is belt driven, it shall meet the requirements of B.5.4.1 through B.5.4.3. [**1901:**22.5.4]

B.5.4.1 A means shall be provided to mechanically engage and disengage the generator or alternator rotation or to electronically stop the production of electricity from the generator or alternator. [**1901:**22.5.4.1]

B.5.4.2 A voltmeter shall be provided at an operator's panel for any system of this type. [**1901:**22.5.4.2]

B.5.4.3 The belt drive system shall be rated to drive the generator or alternator at the nameplate rating. [**1901:**22.5.4.3]

B.5.5 Line Voltage Power Derived from the Apparatus Low Voltage Power Supply Systems. If the power source derives its input energy from the apparatus low voltage electrical system, it shall meet the requirements of B.5.5.1 and B.5.5.2. [**1901:**22.5.5]

B.5.5.1 The low voltage power supply system shall be installed in compliance with the requirements of NFPA 1901, Chapter 13. [**1901:**22.5.5.1]

B.5.5.2 The alternator and/or battery system shall be adequate to provide power for continuous operation for a minimum of 2 hours at full output. [**1901:**22.5.5.2]

B.5.6 Power Sources Requiring Elevated Engine Speed. If the power source requires the chassis engine to be operating at a specific fixed speed or a specific speed range, it shall meet the requirements of B.5.6.1 through B.5.6.3. [**1901:**22.5.6]

B.5.6.1 The main propulsion engine shall have a governor capable of maintaining the engine speed within the limits required by the power source to meet the frequency control, voltage control, and power output specifications. [**1901:**22.5.6.1]

B.5.6.2 An interlock shall prevent engagement of the generator unless the parking brake is engaged and the transmission is in neutral or not connected to the drive wheels. [**1901:**22.5.6.2]

B.5.6.3 Where the chassis engine drives the generator and electronic engine throttle controls are provided, an interlock shall prevent engine speed control from any other source that would interfere with the generator while the generator is operating. [**1901:**22.5.6.3]