U.S. Department
of Transportation

**Federal Aviation
Administration**

Advisory Circular

Subject: GUIDE SPECIFICATION FOR SMALL, DUAL AGENT AIRCRAFT RESCUE AND FIRE FIGHTING VEHICLES

Date: 12/7/93 **AC No:** 150/5220-19
Initiated by: AAS-100 **Change:**

1. **PURPOSE.** This advisory circular (AC) contains performance standards, specifications, and recommendations for the design, construction, and testing of a family of small, dual agent aircraft rescue and fire fighting (ARFF) vehicles.

2. **SCOPE.** The National Fire Protection Association Standard for Aircraft Rescue And Fire Fighting Vehicles (NFPA 414-1990) forms the basis for this AC. In order to enhance bid competition or to improve cost effectiveness, certain aspects of the performance requirements of the vehicle or fire suppression systems were strengthened, broadened, or made less prescriptive than their counterpart requirements in NFPA 414. In general, the payload and performance requirements of the Class 1 and 2 vehicles covered by this AC are compatible with the use of commercially available chassis for the automotive portion of the vehicle. At the upper limits of Class 3, it may be necessary to go to a custom built chassis to carry the payload and to meet the other performance parameters.

3 **CANCELLATION.** AC 150/5220-14A, Airport Fire and Rescue Vehicle Specification Guide, dated February 25, 1985, is canceled.

4. **APPLICATION.**

a. The Federal Aviation Administration recommends the use of the guidance in this publication for the preparation of ARFF vehicle specifications. For airport projects receiving Federal grant assistance, the use of these standards is mandatory. At certificated airports, the use of equipment meeting these standards is an acceptable means of satisfying the requirements of Federal Aviation Regulations (FAR), Part 139, Subpart D - Operations, subparagraph 139.317, Aircraft rescue and fire fighting: Equipment and agents.

b The testing requirements of this standard will be implemented as follows:

(1) Paragraph 100a, Manufacturer's Certification, and paragraph 100.c., Vehicle Acceptance Tests, are mandatory for all ARFF vehicles which are manufactured for delivery in response to a request for bids issued after the date of this standard.

(2) Paragraph 100b, Prototype Vehicle Tests, is mandatory for all new model ARFF vehicles which are manufactured for delivery in response to a request for bids issued after the date of this standard. Vehicles models currently in production and delivered within 2 years after the date of this standard are exempt from the requirement to furnish prototype tests. For those vehicles that are a duplicate of a model manufactured prior to this standard, the requirements become mandatory 2 years after the date of this standard.

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FIGURE NUMBER

CHAPTER 1. INTRODUCTION

SECTION 1. GENERAL CHARACTERISTICS

1. DEFINITIONS. Terms with meanings unique to or specifically related to ARFF vehicle design, construction, and performance requirements are contained in Appendix 1.

2. EXPECTED USE.

a. This guide specification covers three classes of small all-wheel drive, self propelled, dual agent (combined agent) ARFF vehicles. Vehicles complying with this specification meet the ARFF vehicle requirements of FAR Part 139 for an ARFF vehicle carrying a minimun of 450 pounds of a potassium-based dry chemical and 100 gallons of a premixed AFFF solution.

b. Vehicles meeting this specification will also fulfill the recommended practices for aircraft fire protection at general aviation airports published in AC 150/5210-6C, Aircraft Fire and Rescue Facilities and Extinguishing Agents. In addition, vehicles meeting this specification will fulfill the recommended practices for airport ARFF Categories 1 through 4 published by the International Civil Aviation Organization (ICAO) in Annex 14, Chapter 9, Table 9-2.

c. Unique vehicle requirements to be funded with Federal grant assistance beyond this basic specification must be adequately justified and will be evaluated on a case-by-case basis by the FAA. See Appendix 4 for additional guidance.

3. FIRE SUPPRESSION CHARACTERISTICS.

a. The primary function of the vehicles described in this guide specification is to provide an optimum level of aircraft fuel fire suppression capability throughout the critical rescue and fire fighting access area on an airport for the lowest practical cost. These vehicles may also be suitable for other fire protection assignments at the airport.

b. The primary agent system carried by these vehicles is a mechanical foam/water system using an aqueous film-forming-foam (AFFF). These vehicles will also carry a dry chemical (500 lbs of sodium- or 450 lbs of potassium-based) or a Halon 1211 (or an acceptable alternative clean agent) extinguishing agent as the complementary agent system.

NOTE: Vehicles designed for the simultaneous discharge of the foam/water solution and the complementary agent through "twined" or "dual" turrets and/or handlines shall use an AFFF and a potassium bicarbonate-based dry chemical agent only.

c. The agent system, ancillary equipment, and performance requirements for these vehicles are designed to permit the use of basic, commercially available chassis normally used in the production of all-wheel drive highway vehicles. The vehicle class and its principal payload of minimum usable agent quantities, (rated capacity) is shown in Table 1.

	Foam Solution		Dry Chemical*	
Class	Gal (U.S.)	Liters	Pounds	Kilograms
1	100	400	500	225
2	300	1,100	500	225
3	500 & over	1,900+	500	225

* 500 lbs of sodium- or 450 lbs of potassium-based dry chemical agent.

Table 1. Minimum Usable Agent (rated capacity)

SECTION 2. ERGONOMICS

4. CREW SPACE.

a. All crew space shall be restricted to the interior of a fully enclosed cab. The maximum crew capacity of the cab (seated positions with approved seat belts) shall be clearly posted on a label in the cab.

b. Where practicable, instruments shall be used in preference to warning lights. A means shall be provided to test the condition of all warning light bulbs added to the commercial vehicle to support the extinguishing agent systems.

c. Instruments and warning lights shall be displayed so that they will be useful, convenient, and visible to the driver.

d. Any instrument panels added to the basic chassis by the ARFF vehicle manufacturer shall either be easily removable as units or hinged for back access. Quick disconnect fittings shall be used for all electrical connections to the instrument panel. All instruments and gauges shall be illuminated.

e. Provisions shall be made to mount radio(s) and the associated controls so that they shall be operable by the driver and at least one other crew member without leaving the cab or removing their seat belts. The mounting provisions shall take into consideration the fact that radio operating equipment may include boom/microphone headsets with appropriate controls, radio interconnects, remote- or foot-operated push-to-talk switches, and/or charger-mounted handheld units as specified by the purchaser.

f. All rotating or reciprocating parts, all parts which have operating temperatures above 120° F (49° C), all parts which are electrically energized or which are by nature or location a hazard to the safety of operating and maintenance personnel during their normal duties, shall be insulated, enclosed, or guarded.

g. All space which is occupied or space from which work is performed during operations, servicing, and maintenance of the vehicles shall be free from hazardous protrusions, sharp edges, cracks, or other elements which might cause injury to personnel.

5. RIDE QUALITY.

a. The design objective for the vehicle ride quality shall be to permit operation over rough roads and off-road terrain found at the airport of intended service at speeds up to at least 15 mph (24 km) without causing injury to the operating personnel (wearing seat belts) or damage to the vehicle within commercial chassis standards.

b. The design objective for all vehicle and fire extinguishing system controls shall be to permit driving and fire fighting operations which do not require exertion of effort by operating personnel in excess of the limits specified in MIL-STD-1472.

6. CONTROLS.

a. All the controls necessary for the full operation of the vehicle and for activating the fire fighting system shall be within reach of the driver. Controls for the activation and use of the fire extinguishing system(s) shall also be within operational reach of a second crew station or duplicated for that crew station.

b. Fire fighting equipment normally removed from the vehicle for fire fighting operations and agent system controls located on the vehicle exterior shall be placed between 24 and 66 inches (60 and 165 cm) above the ground, catwalks, or deck plates, as applicable.

7. SAFETY FEATURES.

a. A warning siren/device shall be provided.

(1) It shall be a multi-tone, multi-volume, state-of-the-art device used as a common industry practice on emergency vehicles.

(2) It shall produce a minimum sound of 95 decibels at 100 feet (30 m) directly in front of the vehicle and 90 decibels at 100 feet (30 m) and 45 degrees left and right of front center.

(3) It shall be mounted so as to be protected from drippings from the turret and water splashed up by the tires. The control(s) shall be accessible to both the driver and a second crew member.

b. A horn shall be provided and mounted to achieve optimum sound projection to the front of the vehicle. A control button or horn ring shall be located at the steering wheel.

c. A "vehicle backing" warning device, audible up to 25 ft (7.5 m) behind the vehicle shall be provided. Shifting the transmission into reverse shall activate this device.

SECTION 3. DESIGN CRITERIA

8. PERFORMANCE The design objective for the vehicle shall be performance in accordance with Chapter 2, Section 7. Performance for the fire extinguishing systems shall be in accordance with Chapter 3, Section 8.

9. FLEXIBILITY. The design objective for the vehicle frame, suspension, and mounting of major components shall be to provide the capability for diagonally opposite wheel motion up to 10 inches (255 mm) above ground without raising the remaining wheels from the ground or causing interference or parts failure.

10. MAINTAINABILITY.

a. The vehicle chassis selected to meet the requirements of this guide specification shall be suitable for the expected use if it is designed and built in a manner that:

(1) permits maintenance with commercially available, general purpose mechanic tools and equipment; metric sizes are permitted if required tools are "standard" and "commercially available,"

NOTE: The ARFF vehicle manufacturer shall determine whether or not the maintenance manual provided by the chassis manufacturer fulfills the applicable requirements of paragraph 101. If it does not, the ARFF vehicle manufacturer shall provide a supplement to the manual.

(2) limits the number of tools and the variety of spare parts required for maintenance by such design practices as reducing the variety of bolt sizes, light bulb sizes, wire gages, tubing and pipe sizes consistent with safety and performance requirements,

(3) operates with standard commercial lubricants. Grease and oil seals shall be of a design and location to provide accessibility for inspection, servicing, and replacement. Panels which must be opened for access to lubrication points shall be hinged. Lubrication fittings shall be located in accessible, protected positions. Parts or assemblies which are not readily accessible for direct lubrication or are likely to be overlooked because of inaccessibility, shall have extended fittings. A safety chain or other positive retainer shall attach filler caps to lubrication fill points where practical, and

(4) locates drains, filler plugs, grease fittings, hydraulic line-bleeders, and checkpoints so that they are readily accessible and do not require special tools for proper servicing.

b. Any modifications to the chassis needed to accommodate the installation of the fire suppression systems, cabinets, or other required equipment shall be performed in keeping with the criteria listed above for the chassis and shall be acceptable if it is designed and installed in a manner that:

(1) uses disconnect plugs, receptacles, junction boxes, bus bars, multiple-line connectors in the electrical systems, and readily detachable fittings in hydraulic and pneumatic systems, as applicable. All disconnect points shall be clearly labeled. All hydraulic and pneumatic lines and electrical wires shall be color or number coded,

(2) uses a fastener system that is easily disassembled and reassembled for all cabinets and body-work that must be removed for maintenance, for repair, or for replacement, and

(3) provides accessible connections, where needed, to attach trouble shooting, analytical, and diagnostic equipment to appropriate vehicle subsystems.

11. COMPONENT PROTECTION.

a. All oil, hydraulic, air, water, foam concentrate, complementary agent, and electrical system conduits, tubing, and hoses shall be located in protected positions. They shall be secured to the frame or body structure and, except where a through-frame connector is necessary, shall be fitted with protective looms or grommets at each point where they pass through panels or structural members.

b. All radiator grills, louvers, lamps, tie rods, drive shafts, piping, and other vulnerable components shall be protected within commercial chassis availability by location or by guards to prevent damage from brush, stones, and logs, likely to be incured by the vehicle during off-road performance.

12. PAINTING, MARKING, AND LIGHTING. All vehicles shall be painted and marked to comply with the painting, marking, and lighting standards of the current edition of AC 150/5210-5, Painting, Marking, and Lighting of Vehicles Used on an Airport.

13. INSULATION AND WATERPROOFING.

a. Insulation shall be a fire and water resistant type that will not pack or settle. Provision shall be made to allow the drainage of water from between the walls by gravity flow. The average heat loss shall not exceed 0.24 BTU per square foot (0.76 W/m^2) per degree Fahrenheit per hour. All insulation, which could be exposed to abrasion or damage from equipment storage or operator activities, shall be provided with a protective covering.

b. All components shall be designed, installed, and/or protected so that their normal function will not be impaired by heavy rains, road splash, formation of condensation, or the spillage of extinguishing agents from nozzles and fittings, recharging operations, or leaks in the piping system.

c. The temperature design criteria shall be for vehicle use in a temperature range of 32° F (0° C) to 115° F (43.5° C).

d. If, in the judgement of the purchaser, the operational practices of the ARFF service at a specific airport warrant the use of air conditioning, a system that meets current automotive/truck and environmental protection standards for vehicle air conditioning may be specified by the purchaser. The use of the air conditioning shall not change the acceptable pass/fail criteria for any of the performance tests of the vehicle or the firefighting system by more than $\pm$ 5% when tested in ambient temperatures up to 115° F (43.5° C).

e. If, in the judgement of the purchaser, the climatic conditions combined with the normal operational procedures at a specific airport warrant the use of special freeze protection, a winterization system that meets the requirements of paragraph 50 may be specified by the purchaser.

14. MATERIALS.

a. Materials not specifically covered by this specification shall be of the best quality currently used in commercial practice for ARFF vehicle fabrication.

b. Dissimilar metals shall not be in contact with each other. Metal plating or metal spraying of dissimilar base metals to provide electromotively compatible abutting surfaces is acceptable. The use of dissimilar metals separated by suitable insulating material is permitted, except in systems where bridging of insulation materials by an electrically conductive fluid can occur.

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

d. Protective coatings that chip, crack, or scale with age, extremes of climatic conditions, or on exposure to heat shall not be used.

e. The use of proven, nonmetallic materials in lieu of metal is permitted if that use contributes to reduced weight, lower cost, or less maintenance, and there is no decrease in performance or increase in long-term operations and maintenance costs.

15. through 19. Reserved.

CHAPTER 2. AUTOMOTIVE SYSTEM

SECTION 1. FRAME

20. BALANCE AND CLEARANCES.

a. The weight of the completed ARFF vehicle shall be distributed over the axles and tires of the fully laden vehicle as follows:

(1) The difference in tire load between tires on any axle shall not exceed 5 percent of the average tire load for that axle.

(2) The difference in load between axles should not have a front/rear axle weight relationship greater than 40/60. This relationship shall not exceed 30/70. In addition, none of the component ratings shall be exceeded to accommodate the more asymmetric weight distribution, **AND** all other performance requirements of this specification shall be met.

(3) The front axle shall not be the heaviest axle unless options specified by the purchaser cannot be practically engineered to conform with this requirement. In that case, the weight difference between it and any other axle shall not exceed 5 percent. In addition, none of the component ratings shall be exceeded to accommodate this deviation in the balance/weight distribution, **AND** all other performance requirements of this specification shall be met.

b. Under no circumstances shall axle and tire manufacturer's ratings be exceeded to comply with the above.

c. The fully loaded vehicle shall be able to meet the side slope stability standards of Table 2, performance parameter 2, applicable to its class.

d. The fully loaded vehicle shall meet the clearance standards of Table 2, performance parameters 4 through 8 for standard clearances.

21. DIMENSIONS.

a. The overall height, length, and width of the vehicle shall be the smallest dimensions consistent with the rated payload for its class and the operational performance requirements of the vehicle.

b. Although payload and operational performance are of primary importance, cost-effectiveness and local functional consideration, e.g., existing door, bridge, and tunnel clearances may dictate one or more specific dimensional requirements be specified by the purchaser.

22. LOAD RATING.

a. The functional load rating of the frame shall equal or exceed the actual gross vehicle weight (GVW). The GVW includes complete chassis; cab with attachments, accessories, and equipment; the body with rated agent payload, including a full complement of fuel, lubricant, and coolant; fire fighter protective clothing, equipment, and breathing apparatus in appropriate numbers; fire fighting handtools and appliances; and a 430-pound (190 Kg) allowance for operating personnel.

b. The frame shall not be altered during installation of the fire protection package in any way which will reduce its load rating.

SECTION 2. BODY COMPONENTS

23 COACH WORK. Parts shall be fabricated from materials that will optimize the strengt/weight ratio and still be consistent with the need for heat and corrosion resistance. Self-tapping bolts shall not be used in construction of the apparatus body.

24. COMPARTMENTS. The compartments shall be of weather-tight construction and equipped with closures.

25 HANDRAILS. Handrails or a guardrail shall be provided for personnel safety at all steps, walkways, and elevated work stations: including along the vehicle tank top or tank top fill area, if normally used during fire fighting or vehicle service operations. The rail material shall be heat and corrosion-resistant or provided with a low maintenance, durable, sunlight, weather, heat, and corrosion-resistant finish.

26 RUNNING BOARDS, STEPS, WALKWAYS, AND TOWING DEVICES.

a. Running boards, step surfaces, ladder rungs, walkways, and catwalks shall have anti-skid treads, deck plates, handrails, and guards, as applicable.

(1) The height between steps shall be no more than 20 inches (50 cm).

(2) The lower steps shall be no more than 22 inches (55 cm) from the ground. The lowest steps may extend below the angle of approach or departure or ground clearance limits if they are designed to swing clear.

(3) The tread of the bottom steps shall be at least 8 inches (20 cm) in width. All other steps shall be at least 16 inches (40 cm) in width.

(4) The full width of all steps shall have at least 6 inches (15 cm) of unobstructed toe room or depth when measured from, and perpendicular to, the front edge of the weight bearing surface of the step.

b. Catwalks and deck plates which provide access to the equipment mounted on the vehicle shall withstand the loads imposed by personnel while performing normal service and operational functions.

c. Two towing hooks/eyes shall be attached directly to the frame rails at the front and rear of the vehicle. If requested by the purchaser as an option to the rear towing hooks, a pintle hook may be attached to the rear frame crossmember of the vehicle, if its presence will not interfere with other components necessary for the required performance.

SECTION 3. CAB AND ACCESSORIES

27 CONTROLS. The following cab-mounted controls shall be provided as applicable for the safe and efficient operation of the vehicle:

Accelerator Pedal
Agent Flow Control
All-wheel Drive Control
Brake Pedal
Complimentary Agent System Activation
Differential Lock Control
Dimmer Control
Dome Light Switch, Manual/Door Activated
Flashing Beacon Switch(es)
Foam Concentrate Reservoir Control Valve
Headlight Switch
Heater/Defroster/Air Conditioner Controls
Horn Control
Ignition Switch
Panel Lights Switch with Dimmer
Parking Brake Control
Siren Switch with Microphone
Spotlight Switch(es)
Starter Switch
Steering Wheel, with Self-canceling Direction Signal
Transmission Range Selector
Turret Control
Water Flow Control Valve
Windshield Deluge System Control
Windshield Wiper and Washer Controls

28 CREW SPACE and DOORS.

a. The cab shall:

(1) have seats for a driver and at least one additional crew member,

NOTE: If additional crew positions are a local operational requirement and are specified by the purchaser, they shall be provided.

(2) have space for the instruments, radios, controls, and the safety equipment required by the number of fire fighters intended to occupy the cab without hindering crew operations,

(3) have doors which open to as near a 90-degree angle to the cab side as is commercially available. If needed for operator safety or to facilitate rapid entrance or egress, appropriate steps and handgrabs shall be added to the vehicle. The location of vehicle components or mounted fire fighting equipment shall not obstruct the cab entrances/exits,

(4) be constructed and/or mounted on the vehicle frame to meet the provisions of paragraph 9,

(5) be constructed within established commercial chassis standards for cab strength to prevent cab collapse in the event of a vehicle rollover, and

(6) be weather tight and fully insulated in accordance with the provisions of paragraph 13.

b. The cab roof shall have gutters of sufficient size to prevent foam and water from dripping on the windshield and side windows during turret operation. All cab fresh air vents/intakes shall be baffled and drained in such a way that wind-driven rain and/or water-foam solution sprayed on the vehicle cannot flow into the crew compartment through the air intakes.

c. All glass shall be laminated or tempered, tinted safety type to meet applicable Federal standards and shall be free of imperfections which affect visibility.

d. The design and arrangement of the cab and components shall optimize visibility for a seated driver having seat to eye height of 31-3/4 inches (80 cm).

(1) The lateral field of vision shall be at least 90 degrees left and right of center, i.e., the included angle of vision for the driver is 180 degrees.

(2) The ground must be visible to the

driver at a point at least 15 feet (4.5 m) and beyond from the vehicle through the left two-thirds of the included angle of vision and 30 feet (9 m) from the vehicle through the right third of the included angle.

(3) The angle of visibility above the horizontal for the seated driver looking through the front cab windows shall be at least 5 degrees.

(4) Restriction of the horizontal angle of vision by window frames, corner and door posts, shall not exceed 7 degrees per obstruction.

(5) Forward vision for the driver, looking through the windshield between the forward corner posts of the cab, shall be unobstructed.

EXCEPTION: A center post is acceptable if the width is under 2 inches (50 mm), and there are no blind areas at a distance of 30 feet (9 m) from the vehicle when viewed by the driver using both eyes while sitting in normal operating position.

e. Cab interior noise level when measured at the driver's ear position shall not exceed 85 dB(A). Measurements shall be performed in accordance with 49 Code of Federal Regulations (Transportation), Chapter III, Section 393.94, 10-1-89 Edition.

f. There shall be an adjustable rear view mirror with a flat glass area of at least 60 square inches (385 cm^2) on each side of the vehicle. In addition to each flat mirror, a wide angle convex mirror of at least 7 square inches (45.2 cm^2) shall be provided.

29. EQUIPMENT. If not provided by the manufacturer of the basic chassis, the items listed below shall be added by the ARFF vehicle manufacturer.

Air Conditioner, if requested
Cab Dome Light
Crew Seats with approved seat belts
Driver's Seat, adjustable fore and aft with approved seat belt
Heater/Defroster with fresh air intake, and with ducts to windshield
Provisions for SCBA at/in/near each seat
Siren/Audible Emergency Warning Device
Sun Visors - 2 or more
Windshield Deluge System
Windshield Washers - two or more with large capacity reservoir
Windshield Wipers - two or more with delay and multi-speed capability

30 INSTRUMENTS AND WARNING LIGHTS. The following instruments and warning lights shall be provided in the cab as applicable:

Air Pressure (brake or other accessories)
All Wheel Drive Indicator
Amber (yellow) Beacon Indicator
Complimentary Agent Tank - Charged Light
Differential Lock Indicator
Emergency Beacon Indicator
Engine Coolant Temperature
Engine Oil Pressure
Engine Tachometer(s)
Foam Agent Tank - Level Indicator
Foam Pump Pressure Indicator
Foam/Water Solution Tank - Charged Light
Fuel Level
Headlight Beam Indicator
High Reach Turret Deployment Indicator
Low Air Pressure Warning
Speedometer/Odometer
Voltmeter - Expanded Scale
Water Pump Pressure
Water Tank Level Indicator

SECTION 4. DRIVE LINE AND CONTROLS

31 AXLES.

a. The axles shall be rated and certified as required by paragraphs 100a(1) and 103a as being suited for the intended use. The axle manufacturer's approved rating shall not be raised by the vehicle manufacturer to conform to the requirements of this specification.

b. Front and rear axles shall have adequate capacity to carry the fully loaded vehicle under the

intended operating conditions. The maximum variation in axle tread shall not exceed that normally found on commercial chassis in the same GVW class.

c. Tractive power at each wheel shall be achieved by use of torque proportioning differentials or other suitable automatic devices which will ensure that each wheel of the vehicle is driven independently of the other wheels as available on commercial chassis.

d. Front axles shall be equipped with steering drive ends designed to eliminate fluctuations in angular velocity of the wheels when they are cramped either left or right at all normal operating speeds.

32 BRAKE SYSTEM. A brake system shall be provided which has been tested and certified in accordance with the requirements of paragraphs 104 and 121. The system shall include an all-wheel, split-circuit, power-assisted service brake and a parking brake.

a. Air Supply. Vehicles supplied with air brakes shall have:

(1) A compressor that shall:

(a) be engine driven,

(b) have capacity sufficient to increase air pressure in the supply and service reservoirs from 85 to 100 psi, (552 to 690 Kpa) in 25 seconds or less, when the engine is operating at the vehicle manufacturer's maximum recommended revolutions per minute,

(c) have the capacity for quick buildup of tank pressure from 5 psi to the pressure required to release the spring brakes within 12 seconds, and

(d) have an automatic air drying system immediately downstream from the compressor.

(2) A service air reservoir that shall:

(a) have a volume at least 12 times the total combined brake chamber volume at full stroke, and

NOTE: If the reservoir volume, inclusive of supply lines, and air dryer volumes, is greater than the minimum required, proportionately longer buildup time is acceptable using the following formula:

$$\text{Maximum Time (sec)} = \frac{\text{Actual reservoir capacity x 25}}{\text{Required reservoir capacity}}$$

(b) have drain(s) and safety valve(s) as necessary for safe and efficient operation.

(3) When specified by the purchaser, a pull-away air connection for charging of air tanks from an external air source or a built-in electric air compressor shall be provided to maintain air supply automatically.

(4) Visual and audible low air pressure warning devices. The low pressure warning device shall be visible and audible from the inside of the cab.

b. Parking Brake. The parking brake shall be operable by the driver and shall meet the parking brake holding performance standard of Table 2, performance parameter 11.

c. Service Brake. A service brake powered by air, hydraulic, or air-over-hydraulic, which meets the performance standard of Table 2, performance parameter 10, shall be acceptable.

(1) A chamber shall be provided for each brake for each wheel and shall be mounted as available on commercial chassis.

(2) The service brake shall be capable of providing at least one power-assisted stop with the vehicle engine off, which meets the service brake stopping distance standard of Table 2, performance parameter 10.

33. STEERING. All classes of vehicles shall have power-assisted steering.

a. The power assist shall have sufficient capacity so that no more than 15 pounds (6.8 kg) pull is necessary on the steering wheel rim to turn the vehicle wheels from lock to lock.

b. The design of the steering mechanism shall permit manual steering after power-assist failure with no more than 160 percent of the force required on the steering wheel rim to comply with 33a above.

c. The vehicle shall perform as follows when driven on a steering pad around a 100-foot (30 m) radius circle:

(1) With increasing speed, the steering angle shall increase; oversteer is not acceptable.

(2) The vehicle shall remain on the prescribed path until achieving a speed at least equal to that specified for its class in Table 2, performance parameter 3.

d. The wall-to-wall turning diameter shall meet the requirements of Table 2, performance parameter 8. Nonfunctional vehicle extensions shall not be added to meet this requirement.

34. SUSPENSION.

a. The the total unsprung weight of the vehicle will not be greater than 20 percent of the in-service vehicle gross weight.

b. Double acting shock absorbers or an equivalent energy absorbing/motion damping device shall be provided for all axles or bogies.

c. Energy absorbing stops shall be installed so as to prevent damage to axles, drive shafts, engine oil pan, or any other portions of the chassis from bottoming.

35. TRANSFER CASE.

a. The transfer case shall be certified as suitable for the intended service in accordance with the requirements of paragraph 103.

b. A transfer case which is either separate or integral with the transmission shall be acceptable.

c. A single or a 2-speed transfer case, as required to meet the performance requirements, shall be acceptable.

d. A transfer case which has either a front axle disconnect or an overriding clutch to compensate for difference in travel between front and rear wheels shall be acceptable.

e. The transfer case shall incorporate a drive to the front and rear axles, engaged at all times during the intended airport service, which will not allow the vehicle to stall as long as the tire(s) of any axle have traction.

EXCEPTION: A driver operated selector may be specified where operational requirements dictate the need for an alternative to full time, all-wheel drive.

36. TRANSMISSION.

a. The transmission shall be certified as suitable for the intended service in accordance with the requirements of paragraph 103.

b. The transmission shall be a continuous drive system. Either hydrostatic, hydrostatic/automatic, or automatic powershift, incorporating a torque converter with suitable torque ratio, shall be acceptable. The use of a transfer case to achieve the required performance is acceptable.

EXCEPTION: A manual transmission may be used for power take-off (PTO) pumps where the chassis manufacturer does not offer automatic with a PTO opening or where PTO output would not provide suitable pump input shaft speed for pump and roll performance.

c. The transmission range selector shall have all positions clearly identified.

d. All drive-line components shall be of the same power ratings, i.e., no reduction in transfer through bulkheads.

e. The hydraulic system shall include oil pumps, oil filter and screens, hydraulic control system, and an oil cooling system capable of limiting the transmission temperature to the maximum recommended by the transmission manufacturer.

f. In addition to meeting the acceleration, gradability, and top speed standards of paragraphs 51, 55, and 57, the transmission shall have sufficient spacing of intermediate ranges to provide a smooth, uniformly spaced transfer of power over the entire operating range.

37. WHEELS AND TIRE ASSEMBLY.

a. The wheel and tire assembly, including the recommended tire inflation pressure, shall be certified in accordance with paragraph 103 as being suitable for the intended service.

b. Rim and tire rating shall conform to Federal Motor Vehicle Safety Standards (FMVSS) 119, 120, and applicable tire and rim association recommendations for the type and size of tires furnished.

c. All tires, rims, and wheels shall be identical.

d. The tires shall provide good lateral stability during off-road mobility use in the terrain and climatic conditions expected at the intended airport. They shall also demonstrate safe on-road handling characteristics for operation on wet pavement.

e. Tires shall have a rated capacity at least equal to the load imposed on each tire measured at each wheel at the ground.

f. Tires shall be reparable and replaceable. Special tools, if required for tire service, shall be identified and, if requested by the purchaser, provided with the vehicle. There shall be a spare tire and wheel/rim assembly provided with, but not mounted on, the vehicle.

NOTE: The principle objective in the selection of the wheel and tire assemblies is to enhance the off-pavement mobility on the terrain encountered at the intended airport and, at the same time, meet highway

automotive performance standards. However, the off-pavement mobility and handling characteristics of a vehicle depend on a number of other factors in addition to tire selection. Additional information to aid the purchaser in the identification of appropriate off-pavement mobility preformance criteria during specification development, as well as during consultations with the vehicle and tire manufacturers, is provided in Appendix 2.

SECTION 5. ELECTRICAL SYSTEM

38. COOLANT HEATER. An engine coolant preheating device shall be provided. It shall have sufficient capacity to maintain the engine at the manufacturer's recommended temperature for rapid starting and for immediate high initial engine performance.

39. LIGHTING AND MARKING SYSTEM.

a. The lighting and marking system, including reflectors, beacons, and clearance lights, shall satisfy the applicable state and Federal safety standards for highway operations.

b. The system shall include:

(1) two or more sealed-beam, halogen headlights with upper and lower driving beams,

(3) at least one taillight and one stoplight, or one combination tail/stoplight on each side of the rear of the vehicle,

(4) turn signals, front and rear, with self-canceling control, a visual indicator, and a 4-way flasher switch,

(5) reflectors, markers, and clearance lights,

(6) nonglare engine compartment light(s) with switches(s) located in the engine compartment, arranged to illuminate both sides of the engine,

(7) two backup lights, one installed on each side of the rear of the vehicle, and

(8) one or more red flashing beacons as needed to meet visibility requirements.

c. Optional.

(1) Spotlights, quartz lights, fog lights, and opereational area service lighting, as requested.

(2) If, under normal local operational procedures, there are circumstances where it is desirable to identify the status of an ARFF vehicle, as other than an ARFF vehicle in emergency response status, at least one amber (yellow) flashing beacon shall, if requested by the purchaser, be provided in addition to the requirements of paragraph 39b.

40. POWER SUPPLIES.

a. All components, such as alternator and circuit breakers, shall be as waterproof/water resistant as the state-of-the-art permits without the use of marine quality components. They shall be easily accessible and protected against exterior fire and engine heat.

b. One of the following electrical systems shall be provided:

(1) 12-volt electrical and starting,

(2) 12-volt electrical/24-volt starting, or

(3) 24-volt electrical and starting.

c. For 12-volt systems, an alternator shall be provided which has a minimum curb idle charging rate of 30 amps. For 24-volt systems, an alternator shall be provided which has a minimum curb idle charging rate of 15 amps. In either case, the alternator shall have a total current output capacity adequate to service the full, anticipated operational electrical load at 50 percent of the governed engine speed or at 50 percent of the maximum recommended engine operating RPM. It shall have automatic regulation.

NOTE: Provisions to handle the additional load imposed by the winterization kit or air conditioning shall be included when either or both of these options are selected by the purchaser.

d. A weatherproof, grounded, polarized male plug (or plugs as required to service the anticipated

electrical load) suitable for receiving 110-volts AC from an outside electrical supply shall be provided.

(1) The plug(s) shall be located/mounted as specified by the purchaser.

(2) The plug(s) shall be wired to a built-in battery conditioner and the engine coolant preheating device.

(3) The matching female receptacle(s) shall be provided with the vehicle.

e. A battery system shall be provided as follows:

(1) The system shall contain at least one heavy duty, 12-volt battery mounted and connected in an approved manner.

(2) Each battery shall have a cold cranking amp (cca) capacity recommended by the engine manufacturer or at least 600 cca for gasoline engines and 800 cca for diesels, whichever is greater.

(3) If a 24-volt starter is provided, the system shall include a solid-state battery circuit connection for the starter.

NOTE: Additional or larger capacity batteries may be necessary on vehicles equipped with the optional winterization kit.

(4) Batteries shall be securely mounted and protected against mechanical damage, water spray, and engine and exhaust heat.

f. If an enclosed battery compartment is provided, it shall be adequately ventilated. The battery connections and the batteries shall be readily accessible for removal and installation, as well as for examination, test, and maintenance. Rollout trays are an acceptable means of providing the required accessibility.

41. STARTER. An electric starting device shall be provided. When operating under maximum load, the current draw shall not cause a voltage drop sufficient to adversely affect the function of other electrical equipment required to be operational during the startup process.

42. WIRING.

a. All wiring installed by the ARFF vehicle manufacturer shall be numbered or color coded for proper identification, shall have stranded conductors, and shall be of a wire gauge commensurate with the anticipated maximum electrical load of the circuit.

b. Wires shall be insulated in accordance with the standards of the Society of Automotive Engineers (SAE).

c. All connections shall be made with lugs or terminals mechanically secured to the conductors.

d. Wiring shall be protected from heat, oil, and physical damage and shall be secured. Appropriate circuit breakers shall be provided.

43. RADIO INTERFERENCE. Radio suppression of electrical system interference shall be in accordance with SAE J 551, Standard on Performance Levels and Methods of Measurements of Electromagnetic Radiation from Vehicles and Devices (20-1000 MHz), or an equivalent radio interference suppression standard.

SECTION 6. ENGINE AND ACCESSORIES

44. COOLING SYSTEM.

a. The vehicle manufacturer shall certify and provide appropriate documentation in accordance with paragraph 100a(2) and 104 that the complete cooling system installation is suitable for the intended service.

b. The cooling system shall be provided with an automatic thermostat.

c. If a liquid-cooled system is provided, it shall:

(1) have the capacity to stabilize the engine coolant temperature within the engine manufacturer's prescribed limits under operational conditions at the ambient temperature range normally encountered at the airport, and

(2) have drain cocks installed at the low point of the cooling system and at such other points as may be necessary to drain the system completely.

d. If an air-cooled system is provided, it shall have the capacity to stabilize the cylinder head and oil temperatures within the engine manufacturer's prescribed limits under operational conditions at the ambient temperature range normally encountered at the airport.

e. When they are provided, radiator or air inlet shutters shall be automatic and shall be "fail safe" in the open position.

45. EXHAUST SYSTEM.

a. The vehicle manufacturer shall certify that the exhaust system is suitable for the intended service.

b. The engine exhaust system shall be constructed of rust-resistant materials and shall be designed and installed so as to prevent the discharge of exhaust towards the ground.

c. The exhaust system shall be muffled and the

exit shall be located to prevent exhaust gasses from entering the closed cab under all operational conditions.

d. System components shall be protected from damage that could result from traversing off-road terrain.

46. FUEL SYSTEM.

a. The vehicle manufacturer shall provide a fuel system which meets the engine manufacturer's installation approval and shall certify that the fuel system is suitable for the intended service.

b. All components shall be installed in a protected location or otherwise protected from operational damage, exhaust heat, and exposure to ground fires.

c. The fuel tank(s) shall:

(1) be constructed of an approved material,

(2) have an accessible drain plug,

(3) have a filler pipe accessible from outside of the cab that is at least 2.25 inches (5.7 cm) in diameter,

(4) have sufficient capacity to provide for a minimum of 100 miles (160 Km) of highway travel and 1 hour of pumping at the full rated discharge if the foam/water agent discharge system is engine driven, and

(5) be so located and mounted that it will prevent gravity feed.

d. An approved filter, mounted in an accessible location, shall be provided for each fuel supply line.

47. GOVERNOR.

a. On those vehicles where the same engine is used for tractive and pump power, an engine governor, which will not adversely affect the automotive or extinguishing agent system performance, shall be provided. It shall be set to limit engine speed so that it cannot exceed the maximum rpm recommended by the engine and drive line component manufacturers.

b. Independent pump engines shall also be provided with a governor that is set to limit engine speed so that it cannot exceed the maximum rpm recommended by the engine manufacturer.

48. LUBRICATION.

a. The vehicle shall operate efficiently and without detrimental effect to any drive train components when lubricated according to the engine and transmission manufacturers' recommendations using standard commercial lubricants.

b. The engine oil filter shall be full-flow type with replaceable element.

c. All moving parts requiring lubrication shall have a means provided for such lubrication. There shall be no pressure lubrication fittings where their normal use would damage grease seals or other parts.

d. The vehicle shall be serviced prior to delivery with lubricants, brake and hydraulic fluids, and a cooling system fluid suitable for use in the temperature range expected at the purchaser's airport.

49. POWER REQUIREMENT.

a. The engine(s) shall be internal combustion, capable of developing the torque and horsepower needed to meet the automotive performance standards of Table 2 and, if applicable, the extinguishing agent discharge performance standards of Table 3 for the vehicle class. This power requirement shall be achieved without exceeding a "no load," governed speed at the peak of a certified gross brake horsepower curve.

b. The engine shall be capable of meeting the specified performance standards while it is operating on commercial grade fuel.

50. WINTERIZATION -- OPTION.

a. If specified by the purchaser, vehicles purchased for use in areas where it is common industrial practice to winterize vehicles shall have a winterization kit installed.

b. The winterization kit shall not degrade the performance of the vehicle or the fire fighting system in ambient temperatures up to 115° F (43.5° C).

c. The winterization kit shall provide sufficient insulation and heating capacity by means of hot circulating liquids to permit satisfactory operation of the vehicle and fire fighting systems for a period of at least 2 hours at ambient temperatures as low as -40° F (-40° C) with the vehicle fully operational and the engine running. At the end of this 2 hour period, the vehicle shall be capable of meeting the requirements of Table 3.

SECTION 7. AUTOMOTIVE PERFORMANCE

51. ACCELERATION. Each vehicle shall meet the standard of Table 2, performance parameter 9.

52. BRAKE SYSTEM. Each type of brake shall meet the stopping and holding standards of Table 2, performance parameters 10 and 11.

53. DYNAMIC AND STATIC STABILITY. The vehicle shall be able to:

a. pump, or if it is a pressurized system, discharge without stream interruption or vehicle instability, while rolling in both directions across a 20 percent side slope with extinguishing agents being discharged in any direction of turret azimuth at maximum rated turret capacity,

NOTE: Foam/water pump- or pressure-discharge and roll requirement is applicable for turret equipped vehicles only.

b. remain stationary while headed in either direction across a 20 percent side slope and while the steering is being moved to maximum turning angle both right and left without any vehicle instability,

c. meet the applicable side slope stability standard of Table 2, performance parameter 2, and

d. meet the applicable dynamic balance standard of Table 2, performance parameter 3.

54. ENVIRONMENTAL CONDITIONS. There shall be no detrimental effects to subsequent operation of the vehicle or any of the fire extinguishing systems after exposure to the following conditions:

a. dust particles as encountered in desert areas,

b. the corrosive effects of salt fog,

c. material decay from fungus and mildew.

d. relative humidity up to 100 percent, as well as wind driven snow, sleet, rain, and vehicle self-splashing of water, and

e. ambient temperature from 32° to 115° F (0° to 43.5° C). If winterized, the performance range shall extend to at least -40° F (-40° C).

55. GRADEABILITY. The vehicle shall be able to perform as follows:

a. ascend a smooth, dry, paved 20 percent grade and maintain a speed of at least 8 mph (13 kph),

b. ascend, stop, start, and continue ascending; descend, stop, start, and continue descending a 20 percent grade at a speed of at least 2 mph (3.2 kph) and, if turret equipped, perform while discharging agent at rated capacity from the primary turret,

c. ascend and descend a dry, hard surfaced, 50 percent grade at not less than 1 mph (1.6 kph), and

d. negotiate terrain which will deflect the diagonally opposite wheels of the truck in alternatively contrary directions at least 10 inches (25 cm) without the remaining wheels losing traction.

56. OPERATIONAL RANGE. The fully loaded vehicle shall be able to:

a. operate continuously for 25 miles (40 km) at speeds up to 60 mph (96 kph),

NOTE. The test route shall include agricultural lands, paved and unpaved roads, and grades typical of those encountered at the intended airport. During this performance evaluation, the vehicle shall operate in all-wheel drive. At least 5 miles (8 km) of this operation shall be "off-road" travel.

b. if turret equipped, operate on smooth, dry, level pavement through a range from 1 mph (1.6 kph) to at least 10 mph (16 kph) while discharging agents from the primary turret at rated capacity without interruption,

c. negotiate pooled water to a depth of 2 inches (5 cm) for a distance of at least 150 feet (45 m) at a speed of at least 40 mph (65 kph) without engine flooding/stalling, loss of directional control, loss of braking, or electrical system(s) shorting,

d. operate for 10 minutes on dry, paved roadway at not more than 2 mph (3.2 kph) at an engine speed that does not result in rough, irregular operation, and

e. ascend dry, paved 8 percent grade for a distance of one-quarter mile (.4 km) at a speed of not less than 20 mph (32 kph).

57. TOP SPEED. The vehicle shall be able to consistently reach a top speed of 65 mph (104 kph) and to maintain such speed on typical paved, level (grades of less than 1 percent) highway surfaces for a minimum distance of 20 miles (32 km) without showing overheat symptoms in any portion of the cooling system or power train.

58. through 69. Reserved.

Table 2. Automotive Performance Standards

PERFORMANCE PARAMETERS FOR FULLY LOADED VEHICLE	VEHICLE CLASS		
	1	2	3
1. Minimum Rated Capacity: a. Foam/water (gallons) b. Complementary Agent (Lbs)	 100 500	 300 500	 500 500
2. Side Slope Stability: Degrees Percent Grade	30° 58%	30° 58%	28° 53%
3. Dynamic Balance: Minimum Speed on 100 Ft. Radius Circle (Mph)	25	25	25
4. Approach and Departure:Angles	30°	30°	30°
5. Interaxle Clearance: Angle	12°	12°	12°
6. Underbody Clearance:	13"	13"	18"
7. Underaxle Clearance at Differential Housing Bowl:	8"	8"	10.5"
8. Wall-to-Wall Turning Diameter:	≤ 3 X vehicle length		
9. Maximum Acceleration Time from 0 to 50 mph: (Seconds)	25	30	30
10. Service Brake: Stopping Distance From:20 mph 40 mph	 Maximum 35 feet Maximum 131 feet		
Hold Fully Loaded Vehicle:	Minimum 50 percent grade Ascending and descending		
11. Parking Brake: Hold Fully Loaded Vehicle	Minimum 20 percent grade Ascending or descending		

Table 2M. (Metric) Automotive Performance Standards

PERFORMANCE PARAMETERS FOR FULLY LOADED VEHICLE	VEHICLE CLASS		
	1	2	3
1. Minimum Rated Capacity: a. Foam/water (liters) b. Complementary Agent (kg)	 379 227	 1136 227	 1900 227
2. Side Slope Stability: Degrees Percent Grade	30° 58%	30° 58%	28° 53%
3. Dynamic Balance: Minimum Speed on 30 M. Radius Circle (kph)	40	40	40
4. Approach and Departure:Angles	30°	30°	30°
5. Interaxle Clearance: Angle	12°	12°	12°
6. Underbody Clearance: (cm)	33	33	46
7. Underaxle Clearance: at Differential Housing Bowl (cm)	20	20	26
8. Wall-to-Wall Turning Diameter:	≤ 3 X vehicle length		
9. Maximum Acceleration Time from 0 to 80 kph: (Seconds)	25	30	30
10. Service Brake: Stopping Distance From:32 kph 64 kph	 Maximum 11 M Maximum 40 M		
Hold Fully Loaded Vehicle:	Minimum 50 percent grade Ascending and descending.		
12. Parking Brake: Hold Fully Loaded Vehicle:	Minimum 20 percent grade Ascending or descending		

CHAPTER 3. FIRE EXTINGUISHING SYSTEMS

SECTION 1. DRY CHEMICAL -- SODIUM/POTASSIUM BICARBONATE BASED

70. AGENT CONTAINER(S) AND COMPONENTS.

a. If a dry chemical system is selected by the purchaser, the container material shall be suitable for the storage of a sodium/potassium bicarbonate based agent as applicable. It shall:

(1) have a minimum rated capacity (working capacity) which meets the agent quantity standard presented in Table 3, performance parameter 7,

(2) be constructed and stamped in accordance with the American Society of Mechanical Engineers (ASME) "Code for Unfired Pressure Vessels,"

(3) be certified in accordance with paragraph 103,

(4) have an accessible, easy open/close, 4-inch ID fill opening and be provided with a compatible funnel to permit filling from dry chemical storage pails,

(5) be designed to allow filling without the removal of any extinguisher piping or components other than the fill cap,

(6) have a pressure relief device to protect the container and the low pressure piping that is certified in accordance with paragraph 103 to conform with appropriate ASME codes, and

(7) have a gauge that indicates the pressure in the agent container at all times.

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

c. A quick-acting agent system activation control shall be accessible to the seated driver and at least one other crew position. A similar control shall be located near the agent handline.

d. The agent pressurization system shall ensure fluidization of the dry chemical at the time of activation. Designs which include the automatic movement of the chemical container to help fluidize the contents shall also include a manual operating feature.

e. There shall be provisions for purging agent from all piping and hose after use without discharging the remaining chemical. Also, there shall be provisions for the depressurization of the chemical container without the loss of the remaining chemical.

71. AGENT DELIVERY PIPING AND VALVES.

a. The piping, couplings, and valves shall be sized to provide the gas flow into the system and the agent flow out of the chemical container needed to meet the requirements of Table 3, performance parameter 1.

b. All piping and fittings shall conform to the appropriate American National Standards Institute (ANSI) Standards. The completed system shall be designed and installed so as to withstand the recommended working pressure of the system.

c. The integrity of the installed discharge piping shall be tested at a pressure equal to 150 percent of the system working pressure.

d. Material for all piping, couplings, and valves shall be resistant to agent, weather, and galvanic corrosion or shall be otherwise protected against corrosion.

e. Piping shall be securely mounted and provided with flexible couplings where needed to minimize stress.

f. Where multiple agent discharge outlets are provided, the pipe and fitting size shall provide the rated flow to each nozzle, regardless of the location of the hose reel or the number of discharge outlets in operation.

g. All valves shall be quarter-turn type selected for ease of operation and freedom from leaks.

72. PROPELLANT, PROPELLANT CONTAINERS, AND COMPONENTS.

a. The propellant gas shall be either dry nitrogen or dry air. Container capacity shall be sufficient to ensure enough gas to discharge all of the agent and to permit purging of all pipes and hose lines after use.

b. All propellant gas cylinders and valves shall comply with U.S. Department of Transportation (DOT) requirements. Cylinders shall bear the DOT marking, including evidence of a current hydrostatic test, and shall be certified in accordance with paragraph 103.

c. Pressure gages shall be provided which will indicate the pressure on the propellant gas system downstream of the pressure regulator and in the propellant cylinders at all times.

d. Cylinder valves, gages, and piping shall be arranged or protected to preclude accidental mechanical damage during fire fighting operations.

e. The pressure reduction system shall automatically reduce the normal storage cylinder pressure to and hold it at the designed operating pressure of the dry

chemical container. The regulator may be of a type without pressure indicating gages.

(1) Pressure regulating devices shall be equipped with a spring-loaded relief valve that will relieve excess pressure in the regulator.

(2) All pressure regulating devices shall be sealed or pinned at the designed operating pressures after final adjustment by the system manufacturer and shall be certified in accordance with paragraph 103.

SECTION 2. HALON 1211 -- OR ACCEPTABLE SUBSTITUTE

73. AGENT CONTAINER AND COMPONENTS.

a. If halon 1211 or an acceptable vaporizing liquid agent substitute is selected by the purchaser, the container shall be suitable for the storage of the agent and shall be constructed in accordance with ASME "Code for Unfired Pressure Vessels" and shall be so stamped.

b. It shall have a fill coupling designed to allow agent tank filling without loss of agent. The coupling shall be provided with a dust cap secured with a safety chain.

c. The applicable requirements of paragraphs 70a(1)-(3) and (5)-(7); 70b, 70c, and 70e also apply.

74. AGENT DELIVERY PIPING AND VALVES.

a. The piping, couplings, and valves shall be sized to provide the gas flow into the system and the agent flow out of the chemical container needed to meet the requirements of Table 3, performance parameter 2.

b. The requirements of paragraphs 71b through 71g also apply.

75. PROPELLANT, PROPELLANT CONTAINERS AND COMPONENTS. The requirements of paragraph 72 also apply here.

SECTION 3. FOAM CONCENTRATE SYSTEM

NOTE: This section does not apply if a premixed foam/water system is selected by the purchaser. See Section 5 for the requirements for that type of extinguishing agent system.

76. CONCENTRATE PROPORTIONER.

a. A foam concentrate proportioning system shall be provided to control the ratio of foam concentrate to water in the foam/water solution being discharged from all orifices normally used for ARFF operations.

(1) The proportioning system for a 6 percent concentrate shall be sufficiently accurate to provide for the discharge of finished foam within the range of 5.5 percent to 7.0 percent foam concentrate in the discharged foam/water solution.

(2) If a foam concentrate other than 6 percent is used, the precision range shall be modified in direct ratio. Thus, a 3 percent concentrate shall be in the range 2.8 to 3.5 percent concentrate in the discharged solution. A 1 percent concentrate shall be in the 0.92 to 1.2 percent range in the discharged solution.

b. This precision shall be maintained for all individual discharges and for the simultaneous discharge of all turrets and handlines while delivering the quantity of concentrate required to meet the agent discharge requirements of Table 3, performance parameters 3, 4, and/or 5, as applicable.

77. CONCENTRATE RESERVOIR AND PIPING.

a. Materials used in reservoir construction and piping shall be compatible with the foam concentrate, the foam/water solution, and water.

b. A rigid or a flexible foam concentrate reservoir shall be acceptable.

(1) If it is separate from the water tank, the reservoir shall be mounted in a manner that limits the transfer of the torsional strains from the chassis to the reservoir.

(2) The reservoir shall be separate and distinct from the crew compartment, engine compartment, and chassis. It shall be removable as a unit.

(3) The reservoir(s) shall have a working capacity sufficient for two tanks of water based on the use of 6 percent foam concentrate. Actual capacity needed to comply with the performance requirements will depend on the rated water tank capacity and the proportioner accuracy.

(4) A flexible reservoir shall be supported

in a manner that does not depend on the fluid level in either the foam or water reservoirs for its structural integrity.

(5) Access provisions shall be made for access for internal and external inspection and service. Reservoirs, large enough to require baffles, shall be provided with access to each baffled compartment.

(6) The reservoir shall be fitted with a sump, complete with anti-swirl baffles and a 1.5 inch (38 mm) minimum diameter drain with a valve and an accessible control.

(7) The reservoir outlet(s) shall be located above the bottom of the sump and shall permit a continuous flow of foam concentrate to the proportioning system with that system supporting the discharge standards of Table 3 during the discharge of 2 consecutive tanks of water.

(8) Reservoirs shall be vented to permit the required fill rate without exceeding the design working pressure and to permit emptying at the maximum design flow rate without danger of collapse. The vent outlets shall be directed to prevent spillage of foam concentrate on vehicle components.

c. The fill system shall be capable of delivering foam concentrate to the reservoir at a rate at least equal to the maximum use rate of the foam proportioning system.

(1) If requested by the purchaser, bottom fill connection(s) shall be provided on Class 3 vehicles and shall be no more than 60 inches (1.5 m) from the ground. The inlets shall be fitted with corrosion resistant (stainless steel or equal) strainers of 1/4 inch (6 mm) mesh, and shall have check valves or be constructed so that no more than .25 gal (1 L) of foam is lost from the reservoir during connection or disconnection of the foam resupply line.

(2) A top fill opening shall be provided which shall be equipped with a No. 10 gauge mesh, corrosion resistant (stainless steel or equal) screen. The fill line from the trough shall introduce foam concentrate into the reservoir to minimize foaming.

d. The foam concentrate piping shall be sized to permit the flow rates needed to meet the agent discharge requirements of Table 3 and shall be arranged to prevent water from entering the foam reservoir.

e. The foam concentrate piping shall be arranged so that the entire system, including any foam concentrate pumps, can be flushed with water from the water tank without contaminating the foam reservoir.

SECTION 4. WATER SYSTEM

NOTE: This section does not apply if the purchaser selects a pressurized, premixed foam/water system. See Section 5 for the requirements of that type of extinguishing agent system.

78. PIPING, COUPLINGS, CONNECTIONS, AND VALVES.

a. A pressure relief valve which is set to ensure that discharge standards can be met and that surges above the designed operating pressure are relieved shall be fitted to the discharge system.

b. All discharge outlets shall have National (American) Standard fire hose coupling threads.

EXCEPTION: If local couplings are not National (American) Standards as specified in NFPA 1963, Standard for Screw Threads and Gaskets for Fire Hose Connections and, if requested by the purchaser, adapters (securely attached to each outlet) shall be acceptable. The adapters shall not add to the overall width or length of the vehicle.

c. All water system piping on the suction side of the pump shall be tested to detect leaks. All water and foam solution discharge piping, together with the agent pump(s), shall be tested at 150 percent of the normal system operating pressure.

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

e. Piping, couplings, and valves shall be sized to provide agent flow to all discharge devices operating to the applicable standards of Table 3.

f. A drain shall be provided in the suction system at the lowest point with a valve for draining all of the liquid from the pumping system.

g. A drainage system with collector tubing from the low points on pump(s) and piping shall be provided.

h. All valves shall be quarter-turn type and selected for ease of operation and leak-free design.

i. Material for all piping, couplings, and valves shall be selected to avoid corrosion.

j. Piping shall be securely mounted and provided with flexible couplings to minimize stress from chassis flexing. Union, gasketed, or other appropriate flexable fittings shall be provided where they are required to facilitate removal of piping.

79. WATER PUMP(S) AND PUMP DRIVE.

a. If it is common with the vehicle drive, the water pump drive shall have sufficient power to meet the automotive performance and foam/water agent discharge standards of Tables 2 and 3; individually and simultaneously, as applicable.

b. If an independent pump engine is used, it shall:

(1) have fuel, electrical, lubrication, hydraulic, and coolant requirements that are compatible with the chassis engine,

(2) have sufficient power capacity to meet the foam/water agent discharge standards of Table 3 under all normal vehicle operational modes and environmental conditions, and

(3) be certified by the manufacturer as suitable for the intended service.

c. The water pump(s) shall:

(1) have sufficient capacity to supply the foam/water solution at the pressures and volumes required to simultaneously fulfill the discharge standards of Table 3,

(2) be a centrifugal type, with single or multiple stage,

(3) be gravity primed from the vehicle reservoir regardless of the water level in the tank, and the associated piping shall be designed and installed so as to prevent air lock, and

EXCEPTION: If design considerations require the water pump to be mounted above the bottom of the water tank, it shall have an automatic priming system.

(4) be constructed of materials which are compatible with water, water/foam solutions, and foam concentrate.

d. The design, construction, and installation of the pump, pump drive system, and associated piping and controls shall:

(1) allow the vehicle motive drive to be engaged while pumping operations are in progress without damage to or lurching of the vehicle, and

(2) allow pump engagement during vehicle operations without engine stall and without more than a slight and momentary reduction in the engine speed, and no damage to any of the components.

e. A means shall be provided to automatically prevent the water pump, and the foam pump if applicable, from overheating while they are engaged and operating at zero discharge.

80. WATER RESERVOIR AND PIPING.

a. The water reservoir shall:

(1) have a minimum rated capacity, (working capacity) which meets the water quantity standard presented in Table 3, performance parameter 8,

(2) be constructed of material suitable for service with the water and/or foam agent intended to be used by the purchaser,

(3) have longitudinal and transverse baffles with openings that are not in-line, where the tank volume exceeds 100 gallons,

(4) be equipped with removable manhole covers, plates, or removable top which will permit access to the sump and for cleaning of baffled compartments,

(5) be fitted with a sump, complete with antiswirl baffles, a 2.5-inch (64 mm) low point drain, and a quarter-turn valve which has an accessible handle,

(6) have a top-fill opening diameter of at least 5 inches (12.7 cm), a screen with maximum 1/4 inch (6.4 mm) mesh, and a gasketed, latchable cap, and

(7) be vented to permit filling and overfilling at the rate specified in paragraph 80c and discharging in accordance with Table 3 without exceeding

the design operating pressure or causing the reservoir to collapse. Overflow shall be directed to the ground.

b. The discharge piping shall be sized to allow sufficient water to the pump for the simultaneous operation of all turrets, ground sweeps, handlines, and undertruck nozzles at the rates specified in Table 3.

c. The fill piping and connections shall be sized to permit filling in no more than 2 minutes when the supply source provides sufficient volume at 80 psi (5.5 bar) at the reservoir fill connection.

SECTION 5. PRESSURIZED, PREMIXED, FOAM/WATER SYSTEM

NOTE: If the purchaser selects a pump-operated (non pressurized) premixed foam/water system, the requirements of Chapter 3, Section 4, paragraphs 78, 79, and 80 shall apply in place of those in Chapter 3, Section 5.

81. AGENT/WATER CONTAINER AND COMPONENTS.

a. If a premixed foam/water agent system is selected, the container material shall be suitable for the long-term storage of water, foam concentrate, and the foam/water solution over a range of concentrations up to 10 percent foam by volume. It shall:

(1) be constructed in accordance with ASME "Code for Unfired Pressure Vessels" and shall be so stamped,

(2) have an accessible fill opening at least 4 inches (10 cm) in diameter that is easy to open and close,

(3) be provided with a compatible funnel to permit filling with foam concentrate from 5-gallon containers,

(4) be provided with a means (calibrated dip stick or other device) that is sufficiently accurate to serve as a guide in recharging partial loads and to determine the contents of the container,

(5) have a gauge that indicates the pressure in the agent container at all times, and

(6) allow filling without the removal of any of the pipes or components other than the fill cap.

b. A means of pressure relief conforming to appropriate ASME codes shall be provided for the container and piping. A check valve shall be provided to prevent agent from being forced back into the propellant gas line.

c. Provisions shall be made for purging agent from the discharge piping and hose without discharging the agent remaining in the container. Provisions shall also be made for depressurizing the container without the loss of the remaining agent.

82. AGENT DELIVERY PIPING AND VALVES.

a. The piping, couplings, and valves shall be sized to provide the gas flow into the system and the agent flow out of the foam/water container needed to meet the requirements of Table 3, performance parameters 3, 4, and/or 5 as applicable.

b. The applicable requirements of paragraph 71b through 71g also apply.

83. PROPELLANT, PROPELLANT CONTAINERS, AND COMPONENTS. The requirements of paragraph 72 also apply here.

SECTION 6. HANDLINES, REELS, AND COMPARTMENTS

84. HANDLINES.

a. **Number and Configuration.** There shall be a minimum of 1 handline and nozzle for each agent carried on this vehicle. The complementary agent handline may be "twinned" with the foam/water handline(s) or installed separately as specified by the purchaser.

b. **Reeled.** If selected by the purchaser, the reeled complementary and foam/water handlines shall:

(1) be able to meet the discharge performance standard of Table 3, performance parameters 3 and 1 or 2, as applicable, with the hose fully unrolled,

(2) have at least 100 feet (30 m) of a hose acceptable for this service on each reel, and

(3) be equipped with a shutoff-type nozzle which will meet the discharge rate, range, and pattern performance standard of Table 3, performance parameters 3 and 1 or 2, as applicable.

c. **Woven Jacket.** If selected by the purchaser, the woven jacket foam/water handline(s) shall:

(1) be able to meet the discharge performance standard of Table 3, performance parameter 4, with the hose fully stretched,

(2) have at least 150 ft. (45 m) of hose in each handline,

(3) be equipped with a variable pattern, shutoff-type nozzle which will meet the discharge and pattern performance standard of Table 3, performance parameter 4, for both foam and water,

(4) meet the requirements of NFPA 1961, Standard for Fire Hose, and

(5) be stored and preconnected in a hose compartment.

NOTE: See the "NOTE" following paragraph 107e(11) for clarification of the handline test discharge rate conditions.

85. HOSE AND REEL COMPARTMENTS.

a. Each hose compartment shall:

(1) have capacity for at least 150 ft. (45 m) of 1.75 in. (38 mm) multiple jacket hose,

(2) be fabricated from corrosion resistant material and designed and constructed to drain by gravity,

(3) be smooth and free from all projections that might damage hose,

(4) **not** have any equipment mounted or located where it will obstruct the removal of the hose,

(5) be located so that the distance between the handline nozzle and the ground, step, or deckplate upon which an operator must stand to initiate pulling the handline from the reel or compartment is not more than 6 ft. (1.8 m) above that surface.

(6) have located in or adjacent to it a manually-operated, quarter-turn, ball-type valve which controls the flow to each handline, and

(7) be weather-tight and fitted with a closure that can be secured in either the open or closed position.

Exception: Top mounted hose beds similar to those provided on structural engines are acceptable if provided with a protective cover.

b. Each hose reel shall:

(1) be positioned to permit hose line removal by one person from any position in a 120° horizontal sector in front of the reel,

(2) be equipped with a friction brake that will prevent the hose from unrolling when vehicle is in motion,

(3) be equipped with a power rewind with manual override, and

(4) have located adjacent to it a quarter-turn, ball-type valve which controls the flow to each handline.

c. Each hose reel compartment, if enclosed, shall:

(1) be provided with hose rollers on the left, right and bottom edges of the reel compartment, and

(2) be weather-tight and fitted with a closure that can be secured in either the open or closed position.

SECTION 7. FOAM/WATER AND COMPLEMENTARY AGENT TURRET(S)

86. GENERAL.

a. Only class 2 and class 3 vehicles shall be equipped with turrets. These vehicles may have individual turrets for the application of foam/water and dry chemical agents or a single, dual agent turret with a foam/water barrel and a dry chemical barrel.

b. All turrets shall:

(1) be capable of being elevated at least 45^{o} above the horizontal,

(2) be capable of rotating at least 90° to either side of center,

NOTE: When two turrets (intended for dual agent discharge) are used, suitable stops shall be installed so that the turret streams do not interfere with each other. Hence, left and right travel will be restricted to something less than 90°.

(3) except as noted above, have a total

traverse of at least 180 degrees,

(4) be operable from the cab and may be manually or power operated. Operating forces shall be less than 30 lbs (13.5 kg), and

(5) be accessible to the driver and to at least 1 other crew member.

c. Where 2 turrets are provided, they shall be designed to permit the selection of separate or simultaneous discharge of the agent and shall be linked together to permit coordinated application by one operator.

87. FOAM/WATER TURRET. It shall:

a. meet the applicable discharge and pattern standards of Table 3, performance parameter 5,

b. be capable of being depressed to discharge agent to within 15 feet (4.5m) of the front bumper of the vehicle at full output using dispersed stream, and

c. be positioned in relation to the dry chemical turret so that the foam pattern can be directed to the ground 10 feet (3m) behind the dry chemical pattern when both turrets are at full depression.

88. DUAL AGENT TURRET. It shall:

a. meet the applicable discharge and pattern standards of Table 3, performance parameters 5 and 6,

b. be capable of being depressed to discharge foam/water agent to within 15 feet of the front bumper of the vehicle at full output using dispersed stream, and

c. have the foam/water barrel positioned in relation to the dry chemical barrel so that the foam pattern falls to the ground 10 feet (3m) behind the dry chemical pattern.

89. HIGH-REACH, EXTENDABLE TURRET -- Option. The need for a practical, high-rise/high-reach/elevating/extendable waterway (device) to replace the conventional turret as the principle 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 under serious development for the past decade. Devices which are operationally practical in the ARFF service environment have only recently become available.

a. If selected by the purchaser as a substitute for the primary turret on a class 3 vehicle, the device provided shall:

(1) meet the requirements of paragraphs 8-5.2, General Requirements and 8-5.3, Capacity Ratings in NFPA 1901-1991, Section 8-5, "Water Tower,

(2) meet the flow range performance criteria of Table 3, Items 5a and b(1)-(3) for the primary water/foam turret for the class 3 vehicle,

(3) meet the foam quality standards of Table 4 for the applicable foam applicator and foam type,

(4) function during ARFF operations without the need for outriggers or other ground contact stabilizers which would render the vehicle immobile or hinder its maneuverability,

(5) achieve the elevation and reach needed to service the highest tail mounted engine for the type of aircraft being protected and start application of agent within 30 seconds of activation. The high rise, telescoping, and/or articulating movement of the boom/tower shall be accomplished with a single lever control),

(6) function as a conventional roof turret and meet the class 3 vehicle requirements of Table 3, item 5, while in the bedded position,

(7) be capable of applying agent to the interior of the aircraft through cargo bay 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,

(8) have a range of motion so as to permit positioning of the nozzle to direct a fire fighting agent stream at least 45 degrees to the longitudinal axis of the fuselage for interior fire extinguishment, and

(9) have sufficient back-up systems to allow for manual override of the single lever boom control and hydraulic system (or other power source) if the primary system becomes disabled.

b. For man-rated or nonman-rated devices an adjustable or dual flow rate nozzle shall be provided to which will allow flow rates suitable for interior aircraft fire fighting.

c. If a man-rated device is selected by the purchaser, access and load ratings shall be adequate to allow a properly equipped fire fighter to use the tools and water/foam or auxiliary agent handlines necessary to perform the functions associated with interior aircraft fire fighting and fight tail mounted engine fires from the fully extended device. If the device is equipped with a ladder attached to the boom or sections for continuous egress, it shall meet the requirements of paragraphs 8-5.2.5.1 through 8-5.2.5.7 of NFPA 1901-1991.

d. If a nonman-rated device is selected by the purchaser, it shall be fitted with the tools/devices needed for a driver/operator to remotely apply agent at the rates needed for effective interior aircraft and tail mounted engine fire fighting functions. The following are examples of such tools/devices:

(1) Auxiliary agent line - capable of discharging either dry chemical or Halon (or acceptable alternative) through an appropriate nozzle while the device is extended out and up to its maximum operational reach. It shall meet the minimum auxiliary agent flow rate and pattern requirements of Table 3, items 1a and b or 2a and b as applicable.

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

(3) Skin penetrator/agent applicator - for penetration of the fuselage to access passenger cabin or cargo compartment fires from outside the aircraft. It shall be moveable in conjunction with the water/foam nozzle to allow proper placement with the nozzle control. It shall meet the minimum water/foam flow rate and pattern requirements of Table 3, items 4a and c.

SECTION 8. AGENT SYSTEM PERFORMANCE

90. COMPLEMENTARY AGENT SYSTEM.

a. If a dry chemical system is provided, it shall meet the standards of Table 3, performance parameter 1 and, if applicable, 6.

b. If a halon or other acceptable vaporizing liquid agent system is provided, it shall meet the standards of Table 3, performance parameter 2.

91. WATER/FOAM AGENT APPLICATORS.

a. Each foam/water handline shall be capable of delivering a finished foam solution which meets the applicable rate, range, and pattern standards of Table 3, performance parameter 3 or 4, as applicable.

b. Each foam/water handline shall deliver finished foam of a quality which meets the applicable standards of Table 4.

c. Each foam/water turret shall be capable of delivering a finished foam solution which meets the applicable rate, range, and pattern standards of Table 3, performance parameter 5, as applicable.

d. Each foam/water turret shall deliver a finished foam of a quality which meets the applicable standards of Table 4.

92. through 99. Reserved.

Table 3. Extinguishing Agent System Performance Standards

AGENT SYSTEM PERFORMANCE PARAMETERS	VEHICLE CLASS		
	1	2	3
1. Dry Chemical Handline: a. Discharge Rate b. Range	≥ 5 to ≤ 7 lbs per sec At least 25 feet		
2. Halon 1211 Handline: a. Discharge Rate b. Range	≥ 5 to ≤ 7 lbs per sec At least 25 feet		
3. Reeled Water/foam Handline: a. Nozzle Flow Rate: +5% b. Straight Stream Pattern c. Dispersed Stream Pattern	≥ 60 gpm ≥ 50 ft reach ≥ 20 ft reach and ≥ 15 ft wide		
4. Woven Jacket Water/foam HL: a. Nozzle Flow Rate: +5% b. Straight Stream Pattern c. Disperse Stream Pattern	≥ 95 gpm ≥ 65 ft reach ≥ 20 ft reach and ≥ 15 ft wide		
5. Foam/Water Turret Discharge: a. Flow Rate: (gpm),(-0%, +10%) b. Stream Pattern/Distances (1) Straight/Far Point (ft) (2) Dispersed/Far Point (ft) (3) Dispersed/Width (ft)	N/A	150 125 25 20	250 125 25 25
6. Dry Chemical Turret Discharge: a. Flow Rate:	N/A	≥ 16 Lbs per sec	
b. Range, Far Point: c. Width:	N/A	≥ 100 Feet ≥ 17 Feet	
7. Complementary Agent Tank: Minimum Rated Capacity (pounds)	500*	500*	500*
8 Water Tank: Minimum Rated Capacity (gallons)	100	300	500
Percent Deliverable: a. On level b. On 20% side slope c. 30% ascending/descending grade	100% 85% 85%	100% 85% 85%	100% 85% 85%

* 500 lbs of Sodium- or 450 lbs of Potassium Bicarbonate Based Dry Chemical.

Table 3M. (Metric) Extinguishing Agent System Performance Standards

AGENT SYSTEM PERFORMANCE PARAMETERS	VEHICLE CLASS		
	1	2	3
1. Dry Chemical Handline: a. Discharge Rate b. Range	≥ 2.35 to ≤ 3.3 kg per sec At least 7.5 M		
2. Halon 1211 Handline: a. Discharge Rate b. Range	≥ 2.3 to ≤ 3.3 kg per sec At least 7.5 M		
3. Reeled Water/foam Handline: a. Nozzle Flow Rate: ±5% b. Straight Stream Pattern c. Dispersed Stream Pattern	≥ 227 Lpm ≥ 15 M reach ≥ 6 M reach and ≥ 4.5 M wide		
4. Woven Jacket Water/foam HL: a. Nozzle Flow Rate: ±5% b. Straight Stream Pattern c. Disperse Stream Pattern	≥ 380 Lpm ≥ 19.5 M reach ≥ 6 M reach and ≥ 4.5 M wide		
5. Foam/Water Turret Discharge: a. Flow Rate: (Lpm),(-0%, +10%) b. Stream Pattern/Distances (1) Straight/Far Point (M) (2) Dispersed/Far Point (M) (3) Dispersed/Width (M)	N/A	560 38 7.5 6	940 38 7.5 6
6. Dry Chemical Turret Discharge: a. Flow Rate:	N/A	≥ 7 kg.per second	
b. Range, Far Point: c. Width:	N/A	≥ 30 M ≥ 5 M	
7. Complementary Agent Tank: Minimum Rated Capacity (kg)	225*	225*	225*
8. Water Tank: Minimum Rated Capacity (liters)	379	1136	1893
Percent Deliverable: a. On level b. On 20% side slope c. 30% ascending/descending grade	100% 85% 85%	100% 85% 85%	100% 85% 85%

* 225 kg of Sodium- or 204 kg of Potassium Bicarbonate Based Dry Chemical.

Table 4. Foam Quality Standards

FOAM CONCENTRATE TYPE (1)(2)						
Protein and Fluoroprotein Air-aspirated			Aqueous-Film-Forming-Foam and Film-Forming Fluoroprotein Foam			
			Air-aspirated		Nonaspirated	
	Expansion Ratio (Range)	Minimum 25% Drain Time (minutes)	Minimum Expansion Ratio	Minimum 25% Drain Time (minutes)	Minimum Expansion Ratio	Minimum 25% Drain Time (minutes)
Hand Lines	8-12	5	5	4	3	1
Turrets	8-12	5	5	4	3	1

(1) *The foams used to test the vehicle foam system performance are assumed to be foams that meet the industry standards for acceptable aircraft firefighting foams. For example, the non-film forming foams, e.g., protein/fluoroprotein foams must be capable of passing Underwriters Standard UL-162 (Type 3 Application) and the film-forming-foams must be capable of passing at least the 50 Ft^2 fire extinguishment test and the burnback resistance test of Mil-F-24385.*

(2) *Foams that are labeled as "universal", "multi-purpose", "polar solvent", "3%/6%" or "alcohol foams" should not be used in an airport ARFF vehicle unless the ARFF vehicle is specifically designed with a proportioning system and a foam storage tank intended to use this type of agent.*

CHAPTER 4. QUALITY ASSURANCE

SECTION 1. GENERAL CONSIDERATIONS

100. CRITERIA FOR VEHICLE ACCEPTANCE. Compliance with this guide specification shall be documented by one or more of the following methods:

a. Manufacturer's Certification.

(1) The ARFF vehicle manufacturer shall comply with this requirement by providing a signed, component manufacturer's application approval for the specific components listed in paragraph 103. The signed application approvals or a clear copy of the original shall be made part of the vehicle documentation package.

(2) The ARFF vehicle manufacturer shall provide a written certification that the specific subsystems, (on the basic chassis chosen or built to support the construction of the ARFF vehicle) listed in paragraph 104 comply with the applicable performance, design, or construction requirements of this guide specification. A signed copy of the certification shall be made part of the vehicle documentation.

b. Prototype Tests.

(1) The tests specified in paragraph 105 shall be conducted by the manufacturer on the "first article," i.e., prototype agent systems, produced to meet the performance criteria of this guide specification. A mutually acceptable third party (independent testing laboratory/service) may be used to conduct the required tests.

(2) A copy of the signed test report(s) shall be made part of the vehicle documentation package. These tests need not be repeated for follow-on production vehicles. However, if substantive changes in design are made or unusual options are requested, which could reasonably be expected to affect one or more of the required performance criteria, the applicable test shall be repeated.

c. Vehicle Acceptance Tests.

(1) The tests listed in paragraph 121 shall be conducted by the ARFF vehicle manufacturer on every vehicle. These tests may be conducted at the airport, at the manufacturer's facility, or at another mutually acceptable test site.

(2) The results of these tests shall be recorded and signed by the test manager. A copy of the signed test reports shall be made part of the vehicle documentation package.

101. TECHNICAL SERVICE AND PERFORMANCE DOCUMENTATION. The vehicle documentation package is a deliverable item, subject to inspection and approval. It shall be provided with the finished vehicle and shall include two copies each of an Operator's Manual, a Parts Manual, and the Maintenance/Service Manual applicable to the specific vehicle. It shall also include one signed copy of each of the certifications and test reports required by paragraphs 100a, b, and c.

a. **Operator's Manual.** It shall include all information required for the safe and efficient operation of the automotive chassis, the fire extinguishing equipment, and any special attachments or auxiliary equipment. The location and function of all controls and instruments shall be illustrated and described. The manual shall at least:

(1) cover preparation of the vehicle for service upon receipt from the manufacturer,

(2) give a general description of and step-by-step instructions for the operation of the vehicle and its fire extinguishing system(s),

(3) provide checklists for the daily maintenance inspections and mission readiness checks that the operator is expected to perform, and

(4) provide schedules for required preventative maintenance and required periodic maintenance.

b. **Parts Manual.** It shall include illustrations and expanded views, as needed, to properly identify all parts, assemblies, subassemblies, and special equipment. All components of assemblies shown in illustrations or expanded views shall be identified by reference numbers which correspond to the reference numbers in the parts lists. The manual shall contain an alphabetical and a numerical parts list in addition to a table of contents. In addition, all parts purchased by the ARFF vehicle manufacturer and installed as part of the completed/delivered ARFF vehicle (other than those received as part of the purchased chassis) shall be listed and cross-referenced with the original manufacturer's name and part number. This parts list shall indicate the quantity of each item used per vehicle.

c. **Maintenance/Service Manual.** It shall

identify any special tools and test equipment required and shall cover troubleshooting and maintenance as well as minor and major repair procedures. The text shall contain performance specifications, tolerances, and fluid capacities; current, voltage, and resistance data; hydraulic, pneumatic, and electrical diagrams; and such other illustrations and expanded views required to permit proper maintenance by qualified mechanics. The manual shall contain an alphabetical subject index as well as a table of contents.

d. **Certification Documents and Test Reports.** These shall be bound or otherwise packaged in a manner suitable for filing.

102. NAMEPLATES AND INSTRUCTION PLATES.

a. All nameplates and instruction plates shall be made of a material which does not deteriorate from weathering, exposure to water, fire fighting agents, vehicle operating fluids, or hydrocarbon fuels and solvents. The information may be engraved, stamped, or etched on the plate. All plates shall be attached with screws, bolts, or rivets appropriate for the location. Each plate shall be mounted in a conspicuous place on or near the item it identifies or for which it gives instructions.

b. Nameplates shall show make, model, serial number, and other such data appropriate for positive item identification.

c. Instruction plates shall provide specific directions to be followed for safe, efficient operation, or servicing the vehicle or equipment. These plates shall include specific warnings or cautions as may be necessary to protect operation and maintenance personnel from such hazards as high voltage, pressure and temperature, sharp edges, moving parts, or hazardous materials. These plates shall be so located and of sufficient size to be readily seen under normal operating and service conditions.

SECTION 2. CERTIFICATION OF PERFORMANCE

103. COMPONENT MANUFACTURER'S CERTIFICATION.

a. If the ARFF vehicle manufacturer is also the chassis manufacturer, a copy of the component manufacturer's certification (signed application approval) shall be provided for each of the following ARFF vehicle components:

(1) Axles

(2) Agent Tank Pressure Relief Device

(3) Agent Storage Container

(4) Engine(s); Prime Mover and Pump

(5) Handline Hose(s) with Couplings

(6) Propellant Gas Cylinder(s)

(7)Propellant Gas Cylinder Regulator

(8) Tires

(9) Transfer Case

(10) Transmission

(11) Wheels

b. If the ARFF vehicle is built utilizing a commercial chasiss, the ARFF vehicle manufacturer shall certify that the chassis selected is suitable for the intended service. In this case, items (1) and (8) through (11) above are exempt from this component certification requirement.

104. VEHICLE MANUFACTURER'S CERTIFICATION. The vehicle manufacturer shall certify in writing that the components or subsystems listed in Table 5 comply with the applicable requirements of this guide specification or a comparable, recognized standard.

TABLE 5. Vehicle Subsystem Component Certification

SUBSYSTEM COMPONENT:	PARAGRAPH NUMBER	TABLE 2 ITEM NO.
a. Brake Systems:		
(1) Air Supply	32a(1) thru (5)	None
(2) Parking	32b	11
(3) Service	32c(1) and (2)	10
b. Cooling System.	44	None
c. Exhaust System.	45	None
d. Fuel System.	46	None

SECTION 3. PROTOTYPE PERFORMANCE

105. PROTOTYPE TEST LIST. The tests listed below shall be conducted by the manufacturer, an agent of the manufacturer, or an independent agent on the "first article" produced to meet the performance criteria of this guide specification. The specific facilities, equipment, test conditions, test procedures, and the pass/fail criteria detailed in paragraphs 106 and 107 of this section shall be used for each function to be tested.

a. Complimentary Agent Systems:

(1) Handline discharge rate and range:

(a) Dry Chemical

(b) Halon

(3) Propellant gas

(4) Purge and vent system

(5) System pressure regulation

b. Foam/Water Agent System:

(1) Flush capability

(2) Handline w/nozzle discharge rate, range and pattern

(3) Proportioning and foam quality

(4) Pump and roll capability

(5) Pump total discharge capacity

(6) Roof turret:

(a) Azimuth and elevation limits, control, and indicator

(b) Control system resistance

(c) Discharge rate, range, and pattern

(7) Tank(s):

(a) Fill, overflow, and vent capacity

(b) Minimum rated capacity

106. COMPLEMENTARY AGENT SYSTEM.

NOTE: If the ARFF vehicle manufacturer provides one of the following forms of documentation: (1) test data that verifies the performance; (2) a performance certificate from a third party for a complementary agent system of the same brand, general size, and flow rate; or (3) similar documentation from the actual complementary agent system manufacturer, that documentation may be submitted as an additional item under the terms of paragraphs 100 and 103 and the test requirements of this section (but not the pass fail/criteria) shall be waived.

a. Facilities.

(1) Agent System Test Series Tests-1, 2, and 3 require a level, open site, free of obstructions within the expected agent range that is suitable for the discharge of approximately 500 pounds (227 kg) of dry chemical.

(2) Tests-1, 2, and 3 require a recognized test material substitute for halon or a closed-loop test fixture.

Note: The free, open-air discharge of Halon for system testing in NOT acceptable.

b. Equipment for the Complimentary Agent System Test Series.

(1) Tests-1, 2, and 3 require a means of removing the agent tank from the vehicle without loss of agent and moving it to the weighing device.

NOTE: Alternatively, the system may be tested as a unit outside the vehicle, providing that the agent tank, related piping, fittings, valves, hose and nozzle(s) are in the same configuration as they will be in when installed on the vehicle.

OR

The system may be tested as an integral part of the completed vehicle as long as the weighing device meets the tolerance requirements of paragraph 106b(2).

(2) A calibrated scale or load cell with an accuracy of $\pm$ 1 percent of the amount of agent to be weighed.

(3) A timer which can be read to $\pm$ 0.5 seconds.

(4) A tape measure or other distance measuring device that can be read to $\pm$ 0.5 inches.

(5) An anemometer capable of reading wind velocities in the range of 0 to 10 mph (0 to 16 kph) with $\pm$ 0.5 mph (0.8 kph) accuracy.

(6) Test-4 requires a means of connecting a pressure gauge or transducer between the low pressure (downstream) side of the regulator and the agent tank inlet valve.

(7) Test-4 requires a calibrated pressure sensing device capable of reading pressure with an accuracy of $\pm$ 1 percent of the pressure to be measured.

(8) Test-4 requires a pressure reading device connected to the piping between the low pressure propellant gas inlet valve and the agent tank top. If the tank is equipped with a gauge having sufficient accuracy, it may be used.

(9) A test report notebook or similar record form to be used as a test report worksheet and incorporated into the documentation package.

c. Test Conditions for Agent System Series.

(1) The complimentary agent tank pressure relief device shall have been certified as required in paragraph 103a or b and shall be operational.

(2) The agent tank shall have been certified as required in paragraph 103a or b and shall be clean, dry, and empty.

(3) Propellant gas cylinders shall have been certified as required in paragraph 103a or b and shall be pressurized to the recommended operational pressure.

(4) Wind conditions shall be in the range of 0 to 5 mph (0 to 10 kph).

(5) The vehicle (or alternative test unit) shall have all agent piping operational.

d. Test Procedures.

<u>TEST-1.</u> Handline Discharge Rate and Range.

NOTE: This test may be combined with TEST-4 if sufficient agent remains in the tank.

(1) Charge the agent tank using the manufacturer's recommended agent and fill procedure. Weigh it and record the gross filled weight.

(2) Reconnect the tank to the system and ensure that fill caps are secure, propellant gas lines are connected, discharge nozzles are in the closed position, and that all fittings and connections are tight.

(3) Pull all handline hose from the reel(s), position nozzles so that they may be discharged onto the test site with no stream obstructions and such that the stream patterns will not overlap. Pressurize the system using the manufacturer's recommended procedure.

(4) Select one of the handline nozzles and hold it in a fixed, horizontal position between 36 and 60 inches (90 and 150 cm) above the ground level. Simultaneously start the timer and fully open the nozzle.

(5) Monitor the time, and after approximately 20 seconds of discharge time has elapsed, simultaneously shut down the nozzle and stop the timer.

(6) Measure the level ground distance from the spot directly below the nozzle to the far edge of the discharge pattern. Record this distance as the range for nozzle number one.

(7) Reweigh the agent tank and record this weight as the discharge weight for nozzle number one.

(8) If there is more than one complementary agent handline, reconnect the agent tank, pressurize the system, and repeat steps (4) through (7) for nozzle number two.

(9) After testing nozzle number two, reconnect the agent tank, pressurize the system, and repeat steps (4) through (7) while simultaneously discharging both handline nozzles.

(10) Calculate the nozzle discharge rates (DR), in pounds per second, as follows:

$$\text{Nozzle \#1: } \frac{\text{Gross Filled Wt - Discharge Wt \#1}}{\text{Time (Seconds)}} = \text{DR}$$

$$\text{Nozzle \#2: } \frac{\text{Discharge Wt \#1 - Discharge Wt \#2}}{\text{Time (Seconds)}} = \text{DR}$$

$$\text{Dual Noz.: } \frac{\text{Dischrg Wt \#2 - Dischrg Wt Dual}}{2 \times \text{Time (Seconds)}} = \text{DR}$$

TEST-2 Propellant Gas Quantity.

NOTE: May be combined with TEST-3.

(1) Weigh the empty agent tank(s) and record the tare weight.

(2) Charge the agent tank using the manufacturer's recommended agent and fill procedure. Weigh the tank and record it as the "gross filled weight."

(3) Reconnect the tank to the system and ensure that fill caps are secure, propellant gas lines are connected, discharge nozzles are in the closed position, and that all fittings and connections are tight.

(4) Pull all handline hose from the reel(s) and position nozzles so that they may be discharged onto the test site with no stream obstructions. Pressurize the system using the manufacturer's recommended procedure.

(5) Simultaneously open all discharge nozzles fully and continue agent discharge until only the pressurizing gas is discharged. Shut down the propellant gas supply.

(6) Reweigh the agent tank and record as the post discharge weight.

(7) Calculate the amount of agent remaining and report the results as follows:

$$\frac{\text{Post Discharge Wt. - Tare Weight}}{\text{Gross Filled Wt. - Tare Weight}} \times 100 = \%\ \text{Agent Remaining}$$

TEST-3 System Pressure Regulation.

NOTE: May be combined with TEST-2.

(1) Charge the agent tank using the manufacturer's recommended agent and fill procedure.

(2) Reconnect the tank to the system and ensure that fill caps are secure, propellant gas lines are connected, discharge nozzles are in the closed position, and that all fittings and connections are tight.

(3) Pull all handline hose from the reel(s) and position nozzles so that they may be discharged onto the test site with no stream obstructions. Pressurize the system to the manufacturer's recommended operating pressure using the manufacturer's recommended procedure and record the agent tank operating pressure.

(4) Simultaneously open fully all discharge nozzles. Continue agent discharge and monitor and record agent tank pressure at 5-second intervals until only the pressurizing gas is discharged. As soon as only propellant gas is being discharged at all nozzles, shut down the propellant gas supply.

TEST-4 Purge and Vent System.

NOTE: May be combined with TEST-1.

(1) Charge the agent tank using the manufacturer's recommended agent and fill procedure.

(2) Reconnect the tank to the system and ensure that fill caps are secure, propellant gas lines are connected, discharge nozzles are in the closed position, and that all fittings and connections are tight.

(3) Pull all handline hose from the reel(s) and position nozzles so that they may be discharged onto the test site with no stream obstructions. Pressurize the system to the manufacturer's recommended operating pressure using the manufacturer's recommended procedure and record the agent tank operating pressure.

(4) Simultaneously open fully all discharge nozzles. Continue agent discharge for approximately 10 seconds and then shut down all nozzles.

(5) Purge all discharge lines and nozzles using the manufacturer's recommended procedure.

(6) Vent the agent tank using the manufacturer's recommended procedure.

e. Pass/Fail Criteria.

(1) The discharge rate from each nozzle shall fall within the range specified in Table 3, performance parameter 1a or 2a, and shall be within $\pm$ 10 percent of each other.

(2) The range from each nozzle shall meet or exceed the standard specified in Table 3, performance parameter 1b or 2b.

(3) When discharged simultaneously, the averaged discharge rate of the two nozzles shall be within $\pm$ 10 percent of either nozzle discharging alone.

(4) There shall be sufficient propellant

gas remaining after agent discharge stops to purge all agent lines clear of agent from the tank through, and including, the hose line(s) and nozzle(s).

(5) The amount of agent remaining in the tank(s) after agent discharge stops shall not exceed five percent of the initial quantity.

(6) The performance of the pressure regulating device shall be acceptable if it is capable of maintaining the tank pressure within the manufacturer's recommended operating pressure range throughout the entire discharge time.

(7) At the end of the purge process for a dry chemical system, loose agent shall not be left laying in the horizontal piping beyond the agent tank valve.

(8) The depressurization or venting process shall allow only minimal quantities, i.e., one pound (.5 kg) or less of the agent to escape from the agent tank.

107. FOAM/WATER AGENT SYSTEM.

NOTE: If the vehicle is equipped with a pressurized foam/water system, and the vehicle manufacturer provides documentation in the form of: (1) test data that verifies the performance; (2) a performance certificate from a third party for a pressurized foam /water agent system of the same brand, general size, and flow rate; or (3) similar documentation from the actual foam/water agent system manufacturer, that documentation may be submitted as an additional item under the terms of paragraphs 100 and 103 and the test requirements (but not the pass fail/criteria) shall be waived.

a. Facilities for Foam/Water Test Series.

(1) A number of tests in this series requires a paved open area suitable for discharging large volumes of foam/water solution at high pressure. In TEST-10, the area must have sufficient strength and size to accommodate the maneuvering of a fully loaded vehicle safely at speeds up to 25 mph (40 kph). In TEST-1, the area must include measured grades of 20 and 30 percent.

(2) An off-road area with similar characteristics to accommodate the maneuvering of a fully loaded vehicle safely at speeds up to 10 mph (16 kph) is also required for TEST-11.

(3) In addition, a site suitable for discharging agent, which includes a measured grade of 40 percent that is at least twice the length of the vehicle being tested, is required for TEST-12. If the alternate draw bar method is used, TEST-12A requires a level, paved test pad adequate for an extended draw bar pull that is also suitable for the discharge of large volumes of agent at high pressure.

(4) All tests require a water supply sufficient to refill vehicle tank(s) as needed.

(5) TEST-1 requires a means of delivering water to the vehicle water tank inlet at 80 psi (5.5 Bar) and in sufficient volume to permit the filling of the tank of the appropriate vehicle class in two minutes or less.

b. Equipment for Foam/Water Test Series.

(1) Those items needed to perform specific tests in this series in accordance with NFPA 412, "Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles."

(2) Vehicle/pump engine(s) speedometer, tachometer, and agent system discharge pressure gauge as installed by the manufacturer.

(3) A timer that can be read to $\pm$ 0.5 seconds.

(4) A supply of foam concentrate sufficient to refill vehicle foam tank(s) as needed.

(5) TEST-1 requires two water pressure measuring devices with an accuracy of $\pm$ 1 percent of the pressure being measured.

(6) TEST-2 requires two calibrated sight gauges and a liquid volume measuring device with an accuracy of $\pm$ 0.1 percent of the volume being measured.

(7) TESTS-3, -4, -10, -11, -12, and -12A require a supply of an approved water soluble dye.

(8) If one of the optional flow rate methods described in TESTS-4A or -8A is used, a calibrated sight gauge, or a calibrated, open top receiver of sufficient capacity to collect at least 25 percent of the vehicle water tank volume, or appropriate flow meters capable of being read to $\pm$ 0.1 percent of the liquid volume to be measured will be needed.

(9) TESTS-7, 8, and 9 require a tape measure capable of measuring 30 feet (9 M) with an accuracy of $\pm$ 0.5 inches (1.25 cm), a 3-foot (1 m) carpenter level, a large protractor with an accuracy of $\pm$ 1 degree, and a spring scale or other suitable torque measuring device that can be attached to the turret or turret control handle and has an accuracy of $\pm$ 1 percent of the quantity being measured.

(10) If the alternate draw bar pull method is used in TEST-13A, a load cell, accurate to within $\pm$ 500 lbs. (227 kg), and a variable load dynamometer sled are required.

(11) A test report notebook or similar record form is to be used as a test report worksheet and

incorporated into the documentation package.

c. Test Conditions for Foam/Water Test Series.

(1) Verify and record the fact that the agent system pressure relief valve has been set to the recommended relief pressure and is functioning prior to the beginning of any test in this series.

(2) To ensure test operator safety and to validate the effectiveness of subsystem integration, this series of tests shall be performed and passed in the order presented.

EXCEPTION: TESTS-11 and -14 may be combined.

(3) The temperature of the water and the foam concentrate shall be within the foam manufacturer's recommended operating temperature range.

(4) The water and the foam tanks shall be full at the start and shall be refilled as needed to complete the tests.

(5) The foam concentrate proportioners shall be set at the appropriate rate for the foam concentrate to be used at the airport.

(6) The agent selector shall be set for foam/water discharge.

(7) The vehicle shall be fully loaded with the tires inflated to the manufacturer's recommended operating pressure. Appropriate ballast may be used as needed to account for the crew and equipment allowances.

(8) The vehicle engine(s) and transmission shall be at a normal operating temperature.

(9) Handline(s) shall be fully deployed and the nozzles shall be set for straight stream during discharge rate tests.

(10) The agent pump, fill system, overflow/vent system, water and foam discharge system, foam proportioning system, and primary turret(s) shall be fully operational during these tests.

d. Test procedures.

TEST-1. Fill, Overflow, and Vent.

(1) At the beginning of this test, the vehicle shall be parked on level ground, the water tank fill and vent system shall be fully operational, the water tank(s) shall be empty, and pressure measuring devices shall be attached to the vehicle in such a manner that the internal tank pressure and the tank inlet pressure can be monitored during the tank filling process.

(2) The water supply pressure at the tank inlet shall be maintained at 80 psi (5.5 Bar), $\pm$ 5 percent, throughout the filling and overflow process.

(3) Simultaneously initiate flow to the tank and start the timer. Stop and record the time at the first flow of water from the overflow vent.

(4) Continue the flow of water while maintaining 80 psi (5.5 Bar) at the tank inlet and continue to monitor the tank pressure for an additional 30 seconds (approximately). Shut off the water and record the highest pressure reached during the overflow period.

TEST-2. Minimum Rated Capacity.

(1) With the vehicle parked on level ground and sight gauges attached to both the water and foam concentrate tanks, fill the inlet piping until the water reaches the bottom of the tanks. Do **NOT** record the volume of water used. Add an appropriate quantity of an approved water soluble dye to the foam concentrate tank.

(2) The tank(s) shall be filled using a liquid volume measuring device. At approximately every 2 percent of the tank capacity for the bottom 25 percent and every 10 percent of the remaining tank capacity, the volume added shall be correlated with the sight gauge(s) calibrations. If necessary, a correction table or graph shall be prepared for each sight gauge on each tank. When the tanks are filled to the top, the total volume of water added to each tank shall be recorded as "Water Tank Full" (WTF) and "Foam Concentrate Tank Full" (FCTF).

(3) With the agent system set to discharge foam and tanks completely full, discharge shall be initiated and continued at the maximum turret discharge setting. At the first indication of a discharge pressure drop (pump cavitation), agent discharge shall be stopped. Dye shall be visible in the discharge stream throughout the test.

(4) The volume of water remaining in each tank shall be measured and recorded as "Water Tank Empty" (WTE) and "Foam Concentrate Tank - Load # 1" (FCT-L1).

(5) The difference between the volume of the liquid in the water tank recorded in steps (2) and (4) shall be calculated and recorded as the volume of water discharged from that tank on level ground, i.e., "Rated Water Tank Capacity--Level."

(6) **ONLY** the water tank shall be refilled and steps (3) through (5) shall be repeated until all usable liquid has been discharged from the foam concentrate tank. The volume of water remaining in the foam concentrate tank shall be measured and recorded as "FCT-LX," where X represents the number of loads of water used to deplete the foam tank volume.

(7) The difference between the initial volume (FCTF) recorded in step (2) and the "empty" volume (FCT-LX) from step (6) shall be calculated and recorded as the volume of "foam" discharged from that tank on level ground, i.e. the "Rated Foam Tank Capacity--Level."

(8) Refill both tanks and repeat steps (3) through (7) and determine the "Rated Water/Foam Tank Capacities" with the vehicle positioned as follows:

(a) 20 percent side slope, left side up slope,

(b) 20 percent side slope, right side up slope,

(c) 30 percent ascending grade, and

(d) 30 percent descending grade.

TEST-3. Flush Capability.

(1) Fill the water and foam concentrate tanks with water and add a suitable amount of an approved water soluble dye to the foam tank.

(2) While operating in the foam mode, discharge agent through each water/foam discharge orifice until dye is detected. After dye is seen in the discharge stream of all orifices, shut off the discharge and record the dyed water volume remaining in the foam concentrate tank.

(3) Change the agent system settings to the flush mode and discharge water through each water/foam discharge orifice. As soon as the water runs clear from all orifices, shut off the discharge, record the dyed water volume remaining in the foam concentrate tank, and drain the piping.

TEST-4. Pump Total Discharge Capacity.

NOTE: If the vehicle is equipped with multiple pumps, they shall be operated in parallel during this test.

(1) The vehicle engine(s) shall be started.

(2) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed. Observe and record pump pressure.

(3) Adjust roof turret elevation to optimum range position, open roof turret discharge valve, observe range of turret stream, continue flow to allow system pressure to stabilize, and observe and record discharge pressure.

(4) Continue turret discharge and initiate additional discharge from each of the other applicators in its turn until all applicators are discharging simultaneously in straight stream pattern.

NOTE: As each additional applicator is turned on, the range of the initial turret stream and the initial range of each added appliance stream should be compared by observing the system pressure and, after system pressure stabilization, record the pressure.

(5) Continue discharging with all applicators flowing until the system pressure has stabilized. Record the pressure and stop the test.

TEST-5. Handline Nozzle Discharge Rate.

NOTE: If the vehicle is equipped with multiple pumps, they shall be operated in parallel during this test.

(1) Adjust handline nozzle pattern(s) to straight stream position. If the nozzle is non aspirated, repeat this test or one of the optional tests with the nozzle pattern setting in the fully dispersed position.

(2) The vehicle engine(s) shall be started.

(3) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed. Observe and record pump discharge pressure.

(4) Open handline nozzle control valve to full flow position and start timer.

(5) Continue discharge and observe the discharge pressure gauge. At the first sign of a significant drop in discharge pressure, stop the watch and disengage the water pump. Record the time.

(6) Calculate the discharge rate (DR) as follows:

$$DR = \frac{\text{Minimum Rated Tank Capacity (Unit Vol)}}{\text{Discharge Time (min)}}$$

(7) Service the vehicle and repeat steps (1) through (6) for each handline.

TEST-5A. Optional Procedures: Using sight gauge, calibrated open top receiving tank, or flow meter.

(1) Repeat steps (1) through (3) of Test-5 and proceed with (a), (b) or (c) bleow.

(a) **Sight Gauge.** Open the discharge valve to full flow position and monitor the discharge pressure gauge. After the pressure stabilizes,

simultaneously read initial tank volume (ITV) on sight gauge and start the timer. After approximately 50 percent of the remaining water has been discharged, simultaneously read the remaining tank volume (RTV) and stop the timer. Report the discharge rate based on the sight gauge results calculated as follows:

$$DR = \frac{\text{Initial Tank Vol - Remaining Tank Vol}}{\text{Discharge Time (min)}}$$

OR,

(b) **Flow Meter.** Open discharge valve to full flow position, monitor discharge pressure gauge and after pressure stabilizes, read and record flow rates at 15 second intervals during discharge of at least 50 percent of the minimum rated tank capacity. Report the discharge rate based on the averaged flow meter readings.

OR,

(c) **Calibrated Receiver.** Open discharge valve to full flow position, monitor discharge pressure gauge and after pressure stabilizes, simultaneously direct the handline discharge stream into the open top of the calibrated receiver and start the timer. When the receiver is full, stop the timer and shut down the stream. Repeat the process three times, calculate the results as shown below and report the average.

$$DR = \frac{\text{Calibrated Receiver Tank Volume}}{\text{Discharge Time (min)}}$$

TEST-6. Handline Nozzle Discharge Range and Pattern.

NOTE: This test may be combined with Test-14.

(1) The vehicle engine(s) shall be started.

(2) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed.

(3) The test measurements for range and pattern of the foam/water solution discharge shall be conducted as described in NFPA 412.

TEST-7. Roof Turret(s) Azimuth and Elevation Limits.

NOTE: If provided, the turret power assist system shall be fully operational during this test.

(1) The turret shall be pointed parallel to the vehicle length and elevated to the maximum vertical travel. The angle formed by a horizontal level line through the vertical rotation axis and the turret barrel centerline shall be measured and recorded.

(2) The turret shall be rotated to its maximum horizontal travel, both left and right of the straight ahead position, when the turret is:

(a) at maximum vertical depression,

(b) at maximum elevation, and

(c) in the horizontal position.

The angle of turret rotation, left and right of center, for each of these configurations shall be measured and recorded.

(3) Markers or a line shall be placed perpendicular to the vehicle centerline and 15 feet (4.5 M) in front of the forward edge of the front bumper. The turret shall be:

(a) aimed parallel to the vehicle centerline,

(b) lowered to its maximum vertical depression,

(c) set for maximum dispersed pattern, and

(d) set to operate at maximum design flow rate.

With the turret at these settings, the agent system shall be activated and water shall be discharged. The point of impact relative to the line or markers shall be noted and the actual distance measured and recorded.

TEST-8. Roof Turret Control System Resistance.

NOTE: If provided, the turret power assist shall be fully operational and used during the control force measurements.

(1) A suitable spring scale or other torque measuring device shall be attached to the turret in such a manner that the forces at the turret control handle can be measured.

(2) The turret discharge shall be set for a straight stream at maximum flow rate. Measure and record the force required to:

(a) start turret movement from the center and continue the movement from the center to each of the left and right stops,

(b) start turret movement from the full left and right stops and continue the movement to the opposite stop,

(c) start turret movement from horizontal position and continue the movement to both the elevated and the depressed stops, and

(d) start turret movement from both the elevated and depressed stops and continue the movement to the opposite stop.

(3) The turret discharge shall be changed to maximum flow with dispersed pattern and steps (2)(a) through (d) shall be repeated.

TEST-9. Turret Discharge Rate.

NOTE: If the vehicle is equipped with multiple pumps, operate them in parallel during this test.

(1) Adjust turret to full flow, straight stream pattern and elevate to optimum range position.

(2) The vehicle engine(s) shall be started.

(3) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed. Observe and record pump discharge pressure.

(4) Open turret discharge valve to full flow position and start timer.

(5) Continue discharge and observe the discharge pressure gauge. At the first sign that the tank is empty (a significant drop in discharge pressure, i.e., pump cavitation is starting) stop the timer and disengage the water pump. Record the time.

(6) Calculate the discharge rate DR as follows:

$$DR = \frac{\text{Minimum Rated Tank Capacity (Unit Vol)}}{\text{Discharge Time (min)}}$$

(7) The turret pattern adjustment shall be changed to the fully dispersed pattern. Retain the full flow discharge and elevation/optimum range setting. Repeat (2) through (7).

(8) If the turret is of the dual flow design, change the turret flow rate to the low flow setting and repeat steps (1) through (7).

TEST-9A. Optional Procedures: Sight Gauge or Flow Meter.

(1) Repeat steps (1)-(3) in Test-9 and proceed with (a) or (b) below.

(a) **Sight Gauge.** Open discharge valve to full flow position, monitor discharge pressure gauge, and after pressure stabilizes, simultaneously read initial tank volume (ITV) on sight gauge and start the timer. After approximately 50% of the remaining water has been discharged, simultaneously read the remaining tank volume (RTV) and stop the timer. Report the discharge rate DR based on sight gauge results calculated as follows:

$$DR = \frac{\text{Initial Tank Vol - Remaining Tank Vol}}{\text{Discharge Time (min)}}$$

OR,

(b) **Flow Meter.** Open discharge valve to full flow position, monitor discharge pressure gauge and after pressure stabilizes, read and record flow rates at 15 second intervals during discharge of at least 50 percent of the minimum rated tank capacity. Report the discharge rate based on the averaged flow meter readings.

(2) The turret pattern shall be changed to the fully dispersed pattern. Retain the full flow discharge and elevation/optimum range setting. Repeat (1)(a) or (1)(b).

(3) If applicable, change the turret flow rate to the low flow setting and repeat steps (1)(a) or (1)(b).

TEST-10. Turret Range and Pattern.

NOTE: Test-10 may be combined with Test-14.

(1) The vehicle engine(s) shall be started.

(2) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed.

(3) The test measurements for range and pattern of the turret(s) foam/water solution discharge shall be conducted as described in NFPA 412.

TEST-11. Pump and Roll Capability--Paved Surface.

NOTE: Test-11 may be combined with Test-12.

(1) The vehicle shall be slowed to approximately 5 mph (8 kph), the primary turret(s) and ground sweep or bumper turret shall be prepared to discharge, and agent discharge shall be initiated through the primary turret(s) and the ground sweep/bumper turret.

(2) The vehicle shall be maneuvered forward and backward while discharging and operating at various speeds up to 5 mph (8 kph). The agent pump(s) shall also be disengaged and engaged for at least 3 cycles while maneuvering at these speeds. While continuing to

maneuver and discharge agent, observe agent discharge pressure gauge for fluctuations until the water tank is empty. Record agent discharge pressures at 15-second intervals and note any irregular pump performance.

TEST-12. Pump and Roll--Off-Road. The vehicle shall be serviced and moved to a suitable off-road test site. Repeat step (2) of Test-11 above.

TEST-13. Pump and Roll--On Grade. The vehicle shall be serviced and moved to a 40 percent grade site.

(1) The vehicle shall be positioned at the bottom of the grade and discharge initiated through the main turret(s) at full rated discharge. Record the stabilized discharge pressure.

(2) Immediately upon stabilization of the discharge pressure, initiate ascent of the grade and achieve a speed of at least 1 mph (1.6 kph).

(3) During the ascent, the vehicle shall be brought to a stop and then resume its ascent, regaining a speed of at least 1 mph (1.6 kph) before ending the test. Record the actual speed achieved and any changes in discharge pressure.

TEST-13A. Pump and Roll--Alternate To Test On Grade.

NOTE: If an actual 40 percent grade is not available, the vehicle may be coupled to a "40 percent grade equivalent" draw bar load.

(1) The load cell reading (in unit force per square unit area) required to simulate the 40 percent grade must equal, (sin 21.8°) x (gross vehicle weight) divided by the (square unit area of the load cell).

(2) With the vehicle coupled to the appropriate simulated grade/load, the test shall be conducted as described in Test-13 above.

TEST-14. Proportioning and Foam Quality.

NOTE: This test may be combined with Tests-6 and/or 10.

(1) The vehicle engine(s) shall be started.

(2) The agent pump(s) shall be engaged and brought up to pumping pressure with all agent applicator outlets closed.

(3) The foam/water solution discharged from each of the applicators listed below shall be tested for foam concentration, expansion ratio, and 25 percent drain time as described in NFPA 412. While discharging individually and while discharging during combined simultaneous discharge, the foam concentrate delivered by each of the following applicators shall be determined and reported:

(a) roof turret at full discharge,

(b) if applicable, roof turret at one half discharge, and

(c) handline(s) with nozzles provided with truck.

e. Pass/Fail Criteria.

(1) **Test-1.** The performance of the water tank inlet system shall be acceptable if the total fill time, when using an inlet water supply with a constant pressure of 80 psi (5.5 Bar) (± 5%) at the tank inlet, is no more than 2 minutes.

(2) **Test-1.** The tank vent system shall be acceptable if the internal tank pressure does not exceed the tank manufacturer's recommended operating pressure at any time during the fill or overflow test.

(3) **Test-2.** The foam concentrate tank and the usable capacity shall be acceptable if it meets or exceeds the requirements of paragraph 77.

(4) **Test-2.** The water tank and the usable capacity shall be acceptable if it meets or exceeds the requirements of paragraph 80, and the minimum rated capacity conforms to Table 3, performance parameters 8a, b, and c, as applicable to the vehicle class.

(5) **Test-3.** The flush system shall NOT be acceptable if any discharge outlet fails to discharge clear water. The system shall be redesigned or repaired, as appropriate, and the test repeated until all discharge orifices discharge clear water.

(6) **Test-3.** There shall be no increase (evidence of water tank feedback) or decrease (evidence of foam concentrate leakage) in the volume of the dyed water in the foam concentrate tank during flushing. If there is any volume change, the system shall be redesigned or repaired, as appropriate, and the test shall be repeated until the system can be flushed without a gain or loss of liquid in the foam concentrate tank.

(7) **Tests-3, -4, -10, -11, -12, and 12A.** Dye shall be evident in the stream discharging from all appliances at all times during the test.

(8) **Test-4.** The discharge range(s) shall show no signs of deterioration as additional applicators are engaged.

(9) **Test-4.** The stabilized system discharge pressure shall not fluctuate by more than 10 percent when comparing the stabilized discharge pressure of the roof turret flowing by itself to the stabilized discharge pressure of the system with all appliances discharging simultaneously.

(10) **Test-5.** The handline discharge rate shall be acceptable if it meets the criteria of paragraph 84 and the standards of Table 3, performance parameter 3a or 4a, as applicable.

(11) **Test-6.** The handline discharge range and pattern shall be acceptable if they meet the criteria given in paragraph 84 and the standards of Table 3, performance parameters 3b and c, or 4b and c, as applicable.

NOTE: Handline discharge performance criteria are based on testing with the specified minimum length of hose, i.e., 100 feet of hard rubber/reeled hose or 150 feet of woven jacket hose. If additional lengths are requested, the minimum nozzle discharge rates must still be met. Hence, it is understood that higher discharge pressure at the hose inlet or larger diameter hose or both may be needed to meet the minimum nozzle discharge rate.

(12) **Test-7.** The turret travel is acceptable if the horizontal and vertical travel angles and the turret stream near-point of impact meet or exceed the criteria of paragraph 86.

(13) **Test-8.** The forces required to operate the turret shall be acceptable if they are equal to or less than those specified by paragraph 86.

(14) **Test-9/9A.** The turret discharge rate shall be acceptable if it meets or exceed the criteria given in paragraph 87 and the standards of Table 3, performance parameter 5a, as applicable to the vehicle class.

(15) **Test-10.** The turret discharge range and pattern shall be acceptable if they meet or exceed the criteria given in paragraph 87 and the standards of Table 3, performance parameter 5b(1)-(3) as applicable to the vehicle class.

(16) **Tests-11, -12, -13, and -13A.** There shall be no evidence of proportioning error, pressure surge/drops, or flow rate instability during the pump and roll tests.

(17) **Tests-11, -12, -13, and -13A.** The operation of the pump shall not cause the engine to stall under any of the pump and roll test conditions.

(18) **Tests-11, -12, -13, and -13A.** There shall be no evidence of unsafe vehicle dynamics, (e.g., lurching, sudden speed changes, sudden forward or backward motion or stops) resulting from the engagement and/or disengagement of the pumps during the pump and roll maneuvering or while the vehicle is stationary.

(19) **Tests-11, -12, -13, and -13A.** There shall be no unsafe vehicle dynamics resulting from the engaging and/or disengaging of the vehicle drive.

(20) **Tests-11, -12, -13, and -13A.** Foam solution or dye shall be evident in the discharge from all outlets operated during the pump and roll maneuvers.

(21) **Test-14.** The foam concentrate proportioner system shall be acceptable if the foam concentration measured for each agent applicator during individual and combined discharge is within the applicable standard tolerance range specified in paragraph 76.

(22) **Test-14.** The foam generation capability of the foam/water agent system shall be acceptable if the expansion ratio and 25% drainage time of the finished foam meet or exceed the criteriaof paragraph 91b and d and the applicable standards of Table 4 when measured for each agent applicator during individual and combined discharge.

108. through 120. Reserved.

SECTION 4. PRODUCTION VEHICLE PERFORMANCE ACCEPTANCE TESTS

121. PRODUCTION TEST LIST. The tests listed below shall be conducted by the ARFF vehicle manufacturer on every vehicle. These tests may be conducted at the manufacturer's facility, at the airport, or at another mutually acceptable test site. Specific facilities, equipment, test conditions, test procedures, and the pass/fail criteria for each function to be tested are detailed in paragraphs 122 through 141.

a. Acceleration.

b. Air Compressor Capacity.

c. Balance/Weight Distribution.

d. Brake Control.

e. Electrical Charging System.

f. Flexibility of Body and Chassis.

g. Foam/Water Proportioner(s) Tolerance.

h. Foam/Water Solution Pump Discharge Stability.

i. Gradeability.

j. Pressure Test of Piping and Connections.

k. Pump and Roll Capability.

l. Radio Interference Suppression.

m. Roof Turret Discharge Rate.

n. Siren Output, Direction and Magnitude.

o. Stability:

(1) dynamic turning control, and

(2) static side slope stability.

p. Steering System:

(1) operating resistance force requirements, and

(2) wall to wall turning diameter.

q. Top Speed.

r. Underbody Clearances.

s. Vehicle Interior Noise Levels.

t. Visibility; included angles from driver's seat.

122. ACCELERATION.

a. Facilities. This test requires a dry, straight, level, paved surface of sufficient length to accelerate the vehicle from 0 to 50 mph (0 to 80 kph) and to bring it to a safe stop. Sufficient space is needed at each end to turn and reposition the vehicle for a return run.

b. Equipment Required.

(1) The vehicle speedometer and tachometer as installed.

(2) A timer that can be read to $\pm$ 0.5 second.

(3) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) Any elevation between sea level and 2000 ft. (600 m) unless otherwise specified by the purchaser.

(2) The vehicle shall be fully loaded. Appropriate ballast may be used as needed to account for the crew and equipment allowances.

(3) The engine(s) and transmission(s) shall be at normal operating temperature.

(4) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

d. Test Procedure.

(1) Start with the vehicle at rest, the engine at idle, and the transmission in gear. No "wind-up" of the drive trains shall be permitted.

(2) Simultaneously start the timer and begin accelerating the vehicle. Continue accelerating at full throttle until the vehicle reaches 50 mph (80 kph), stop the timer and decelerate/brake to a safe stop.

(3) Record the elapsed time.

(4) This test sequence should be repeated in the opposite direction to cancel the effects of wind and slope. At least three readings in each direction shall be taken. Calculate and report the average acceleration time.

e. Pass/fail Criteria. The acceleration shall be acceptable if the reported average acceleration time meets or is less than the standard of Table 2, performance parameter 9, for the appropriate vehicle class.

123. AIR COMPRESSOR CAPACITY.

a. Facilities. None.

b. Equipment Required.

(1) The vehicle air system pressure gauge(s) as installed.

(2) A timer that can be read to $\pm$ 0.5 second.

(3) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle air system shall be fully operational.

(2) The engine shall be turned off at the start.

(3) The transmission shall be in neutral.

(4) The parking brake shall be set.

(5) The ratio of the actual volume of the installed air reservoir to the minimum required reservoir volume specified in paragraph 32a(2) shall have been or must now be established.

(6) The minimum spring brake release pressure must be known.

d. Test Procedure.

(1) Bleed off air reservoir pressure by operating the service brake until the vehicle air gauge(s) indicate less than 85 psi (5.9 Bar).

(2) Start engine and increase speed to maximum governed rpm and monitor the increase in air pressure. When the pressure reaches 85 psi (5.9 Bar), start the timer. If there is more than one air pressure gauge, start the time when the first gauge indicates 85 psi (5.9 Bar).

(3) Continue monitoring the pressure increase until a minimum of 100 psi (6.9 Bar) is indicated on all gauges, stop the timer, shut off the engine, and record the time.

(4) Bleed off air reservoir pressure by operating the service brake until all vehicle air gauge(s) indicate less than 5 psi (.3 Bar).

(5) Start engine and increase speed to maximum governed rpm and monitor the increase in air pressure. When the gauge for the quick buildup system reaches 5 psi (.3 Bar), start the timer.

(6) Continue monitoring the pressure increase until the gauge for the quick buildup system reaches the value established for the spring brake release pressure, stop the timer, shut off the engine, and verify that the spring brake release will function at that pressure. Record the time.

e. Pass/Fail Criteria.

(1) The acceptable time for pressure in the brake air system reservoir to build from 85 psi to 100 psi (5.9 to 6.9 Bar) shall be 25 seconds or less;

OR

(2) If the volume of the reservoir provided is greater than the minimum required by paragraph 32a(2)(a), a proportionately longer buildup time shall be acceptable. The allowed time shall be calculated using the formula provided in the referenced paragraph.

(3) The acceptable time for the quick buildup system to reach the pressure necessary for spring brake release shall be 12 seconds or less.

124. BALANCE/WEIGHT DISTRIBUTION.

a. Facilities.

(1) This test requires an in-ground commercial vehicle scale or other weighing device that is large enough to accommodate the appropriate vehicle class and has a certified accuracy of $\pm$ 1 percent of the weighed amount.

(2) A clean level area suitable for positioning the vehicle on a set of portable, wheel scales.

b. Equipment Required.

(1) The in-ground scales or weighing device described above.

(2) A set of certified wheel scales with the same accuracy.

(3) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be fully loaded. Ballast shall be used as needed to account for the crew and equipment allowance. Any ballast used shall be of appropriate shape and size and located to represent accurately the item being replaced with respect to the designed center of gravity and payload distribution.

(2) The vehicle shall be free of any accumulations of snow, ice, mud or other material that could "be seen" within the accuracy limits of the scales.

d. Test Procedure.

(1) The gross vehicle weight (GVW) shall be measured.

(2) The load on each axle at the ground shall be measured.

NOTE: The GVW measured all at once on an in-ground scale will be more accurate than the sum of the individual axle measurements. Hence, the individual axle loads shall be proportionately corrected as needed to make the sum of their loads agree with the GVW

measurement.

(3) The load at the ground on each tire shall be measured.

NOTE: Proportionate corrections shall be made to these results as needed to make the sum of their loads agree with the corrected load on the respective axle.

(4) The following calculations shall be made using the results of the measurements made above.

(a) The percent difference in axle load between the lightest and the heaviest axle load:

$$\frac{\text{Heaviest Axle Ld - Lightest Axle Ld}}{\text{Heaviest Axle Load}} \times 100 = \_\_ \%$$

(b) The average tire load for each axle:

$$\frac{\text{Wt Right Tire(s) + Wt Left Tire(s)}}{2} = \text{Load}$$

(c) The percent difference in tire load between the average tire load for a given axle and the difference between the heaviest and the lightest tire load for that axle (calculate for each axle):

$$\frac{\text{Heaviest Tire Ld - Lightest Tire Ld}}{\text{Average Tire Load for Axle}} \times 100 = \_\_ \%$$

e. Pass/Fail Criteria.

(1) The gross vehicle weight shall be acceptable if it does NOT exceed the vehicle manufacturer's gross vehicle rating. The axle manufacturer's published axle ratings shall NOT be increased to meet this requirement.

(2) The difference in load between axles should not have a front/rear axle weight relationship greater than 40/60. This relationship shall not exceed 30/70. In addition, none of the component ratings shall be exceeded to accommodate the more asymmetric weight distribution **AND** all other performance requirements of this specification shall be met.

(3) The front axle shall **NOT** be the heaviest loaded axle.

EXCEPTION: The front axle may be the heaviest in those cases where options specified by the purchaser cannot be practically engineered to conform with this requirement. However, if the front axle is the heaviest, the weight difference between it and any other axle shall not exceed 5 percent. None of the component ratings shall be exceeded to accommodate this deviation in the balance/weight distribution, **AND** all other performance requirements of this specification shall be met.

(4) The load difference between the tires on a given axle shall be NO more than 5 percent of the average tire load for that axle.

125. BRAKING CONTROL.

a. Facilities for Brake Test Series.

(1) Tests-1 and -2 require two ramps or inclines (man made or natural) known to be at least 20 percent and 50 percent grades.

(2) Tests-3 and -4 may be conducted on any paved surface that can support the vehicle weight and the resulting braking forces and is long enough to allow for the combined acceleration, constant speed, and safe braking distance. The site shall be marked out in a lane that is the width of the vehicle to be tested, plus 4 feet (1.2 M).

(3) A road, runway, or taxiway with a marked center line that meets the length, strength, and other conditions specified is an acceptable alternative test site.

b. Equipment for Brake Test Series.

(1) Tests-3 and -4 require a calibrated fifth wheel connected to a ground speed readout device which is accurate to $\pm$ 0.5 percent of the actual measured speed.

(2) Tests-3 and -4 require a brake triggered device which will mark the recorder to show initial brake application.

(3) Tests-3 and -4 require a recording device with sufficient resolution to record the vehicle speed, brake application point, and stop point with the same accuracy as required for the fifth wheel.

(4) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package for the specific vehicle.

c. Test Conditions for Brake Test Series.

(1) The grades used for Tests-1 and -2 shall be dry, smooth, free of loose material, long enough to accommodate the length and strong enough to hold the fully loaded vehicle.

(2) The vehicle shall be fully loaded. Ballast shall be used as needed to account for the crew and equipment allowance. The ballast shall be arranged to distribute the weight in a manner that closely simulates

the items being represented. The ballast shall NOT be shaped or distributed in a manner that creates a favorable, artificial center of gravity.

(3) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

(4) The surface of the site for Tests-3 & 4 shall be level, dry, smooth, and free of any loose material.

d. Test Procedures.

TEST-1. Grade Holding--Parking Brake.

(1) Drive the vehicle in the forward direction up the 20 percent grade, stop using the service brake, and set the parking brake.

(2) Shift the transmission to neutral, release the service brake and monitor the vehicle visually for 5 minutes for any perceptible wheel rotation. Record the results.

(3) Repeat steps (1) and (2) by backing the vehicle up the grade.

TEST-2. Grade Holding--Service Brake.

(1) Drive the vehicle in the forward direction up the 50 percent grade, and stop the vehicle with the service brake.

(2) Continue holding the vehicle with the service brake, shift the transmission into neutral and monitor the vehicle visually for 5 minutes for any perceptible wheel rotation. Record the results.

(3) Repeat steps (1) and (2) by backing the vehicle up the grade.

TEST-3. Stop distance--Service Brake.

(1) Start the vehicle, turn on the strip recorder, accelerate to 20 mph (32 km/h), and maintain that speed for at least 50 feet (15 m).

(2) Apply the service brake as if in a panic stop; hold the brake on until the vehicle stops. Record the recorder print-out of the distance traveled from the initial braking until the vehicle came to a stop. No steering corrections shall be made for vehicle drift during the stop.

(3) Measure and record the perpendicular distance from the nearest lane edge line to the outer most edge of the vehicle's width. Report the measurement as a negative number if the vehicle is outside of the test lane;

OR,

(4) If the test lane has a marked center line, measure and record the perpendicular distance from the center line to the outer most edge of the vehicle that is farthest from the center line of the test lane.

(5) Repeat the steps (1) through (4) for two complete cycles in each direction of the test lane; record each braking distance for 20 mph (32 km/h).

(6) Repeat steps (1) through (5) above except that the test speed shall be 40 mph (64 km/h).

e. Pass/Fail Criteria.

(1) The service and parking brake grade holding performance is acceptable if it complies with the applicable portions of paragraph 32 and meets the applicable standards of Table 2, performance parameters 10 and 11.

(2) For all stop tests conducted in a lane with outer boundary markers, NO portion of the vehicle shall be outside those boundaries after the vehicle stops.

(3) For all stop tests conducted in a lane with a marked center line, the measured distance from the outer most portion of the vehicle to the center line of the lane shall be less than one half of the vehicle width, plus two feet (.6 M).

(4) Each of the four recorded stop distances for the service brake shall meet the applicable stopping distance standards of Table 2, performance parameter 10.

126. ELECTRICAL CHARGING SYSTEM.

a. Facilities. This test requires an area suitable for running the engine(s) while the electrical loads are operating and the charging current and voltages are being measured.

b. Equipment Required.

(1) The vehicle tachometer as installed.

(2) A voltmeter with a range, compatible with the design voltage of the vehicle electrical system, that can be read with an accuracy of $\pm$ 0.1 volt.

(3) Two ammeters with a range, compatible with the current load, that can be read within $\pm$ 1 percent of the actual current flow.

(4) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The batteries shall be fully charged, i.e., the specific gravity of each battery shall be at the manufacturer's specifications.

(2) The vehicle electrical system and charging device shall be fully operational.

(3) The ambient temperature shall be within the range of 50° to 90° F (10° to 32° C).

(4) The voltmeter shall be installed to continuously measure the battery voltage.

(5) An ammeter shall be installed to permit reading of the current flow from the battery to the electrical devices.

(6) A second ammeter shall be installed to permit reading the maximum current flow from the alternator to the rest of the electrical system except the starter.

(7) With all electrical devices turned off, start the engine and allow it to run long enough to recharge the batteries prior to beginning the test.

d. Test Procedure. Voltage and current flow readings shall be recorded for the following conditions:

(1) engine at idle with

(a) battery alone, and

(b) all electrical devices (normally expected to be operating simultaneously) turned on,

(2) engine at 50 percent governed speed with all electrical devices (normally expected to be operating simultaneously) turned on, and

(3) engine at maximum governed speed with all electrical devices (normally expected to be operating simultaneously) turned on.

e. Pass/Fail Criteria. The 12/24 volt electrical system performance shall be acceptable if it meets or exceeds the applicable criteria as follows:

(1) engine at idle with

(a) battery alone, and

(i) Voltage at battery shall remain above 13/25 volts.

(ii) Current output shall equal the battery manufacturer's recommended charging rate or be at least 30/15 amps while battery is charging.

(b) all electrical devices normally expected to be operating simultaneously turned on;

(i) Voltage at battery shall remain above 13/25 volts.

(ii) Current output shall be at least 30/15 amps or shall be equal to the sum of the current demand of the operating electrical devices if that current demand is lower than 30/15 amps.

(2) engine at 50 percent governed speed with all electrical devices (normally expected to be operating simultaneously) turn on, and

(a) Voltage at battery shall remain above 13/25 volts.

(b) Current output shall be equal to the sum of the current demand of the operating electrical devices.

(3) engine at maximum governed speed with all electrical devices (normally expected to be operating simultaneously) turned on.

(a) Voltage at battery shall remain above 13/25 volts.

(b) Current output shall be equal to the sum of the current demand of the operating electrical devices.

127. FLEXIBILITY, BODY AND CHASSIS.

a. Facilities. This test requires a flat area suitable for discharging agent and driving the vehicle onto portable ramps.

b. Equipment Required.

(1) Two double-ended ramps with a flat top at least long enough for the whole tire footprint. The approach and departure slopes of the ramps shall be graded to allow the vehicle to ascend and descend safely. The height of the ramps shall be 10 inches.

(2) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be tested in its fully loaded condition. Ballast shall be used to simulate equipment and crew weights as needed. If ballist is used, it shall be distributed realistically. An artificial center of gravity is not permitted.

(2) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

d. Test Procedure.

(1) Drive the vehicle onto two ramps positioned to raise the diagonally opposite front and rear wheels.

(2) Inspect the vehicle for any visible signs of clearance between the tires and the ground or supporting ramp surfaces, for component interferences, for sheet metal buckling, and for interferences with moving parts including doors and equipment compartment closures. Record the results.

(3) Demonstrate the operation of all electrical, pneumatic, hydraulic, and agent systems including the discharge of agent from all orifices. Record the results.

(4) Drive the vehicle off the ramps, reposition them to raise the other two diagonally opposite front and rear wheels.

(5) Repeat steps (2) & (3) above.

(6) Review the test record for any misfits or malfunctions; make any necessary repairs and repeat the test as necessary.

e. Pass/Fail Criteria.

(1) There shall be no interference between one moving part and any other or between any moving part and an adjacent surface, structural member, or mounting device.

(2) All doors, equipment compartment closures, and hose reels shall function normally.

(3) There shall be no loss of performance in any operating subsystem.

(4) If there is any contact introduced by the twisting motion of the vehicle frame between major components, (e.g., cab, agent tanks, engine compartment(s); engines, pumps, hose reels and the respective compartment walls and mounting fixtures) that contact shall not damage or exhibit the potential to damage either component during the repeated flexing which is expected in normal service.

(5) There shall be no visible signs of clearance between any vehicle tire and the ground or ramp surfaces.

128. FOAM/WATER PROPORTIONER(S) TOLERANCE.

NOTE: May be combined with test in paragraph 129.

a. Facilities. This test requires an open area suitable for discharging a modest volume of foam/water solution at high pressure.

b. Equipment. As required for the Foam Proportioning/Foam Concentrate Test, (Refractometer Test) performed in accordance with NFPA 412, "Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles."

c. Test Conditions.

(1) All foam/water applicator discharge system performance requirements shall have been previously verified by prototype tests as specified in paragraph 105.

(2) Same as for Foam/Water Agent System Prototype Test given in paragraphs 107c(1), (3), (4), (5), and (6).

NOTE: Foam proportioner tolerance shall be tested and evaluated at the fixed, minimum acceptable rate per Table 3. for each type of applicator.

d. Test Procedure. Same as for Foam/Water Agent System Prototype Test given in paragraph 107d, Test-14 **EXCEPT that only the test for foam concentration, (Refractometer test) shall be performed.**

e. Pass/Fail Criteria. The foam concentrate proportioner system shall be acceptable if the foam solution concentration measured for each agent applicator during individual and combined discharge is at the minimum acceptable discharge rate specified in Table 3 for each type of applicator and is within the standard range specified in paragraph 76.

129. FOAM/WATER SOLUTION PUMP DISCHARGE STABILITY.

NOTE: May be combined with test in paragraph 128.

a. Facilities.

(1) An open site suitable for discharging large volumes of foam/water solution at high pressure.

(2) Access to water and to a supply of foam concentrate sufficient to refill vehicle tanks.

b. Equipment Required.

(1) Vehicle pump engine tachometer and agent system discharge pressure gauge as installed by the manufacturer.

(2) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) All foam/water applicator discharge

system performance requirements shall have been previously verified by prototype tests as specified in paragraph 105.

(2) The agent system pressure relief valve shall have been previously verified as being set to the recommended relief pressure.

(3) The temperature of the water and the foam concentrate shall be within the foam manufacturer's recommended operating temperature range.

(4) The water and the foam tanks shall be full at the start.

(5) The foam concentrate proportioners shall be set at the appropriate rate for the foam concentrate to be used at the airport.

(6) The agent selector shall be set for foam/water discharge.

(7) All primary handlines shall be fully deployed.

(8) All applicator nozzles shall be set for straight stream.

(9) If the vehicle is equipped with multiple pumps, they should be operated in parallel during this test.

d. Test Procedure.

(1) The vehicle pump engine shall be started and brought up to maximum recommended operating rpm.

(2) The agent pump(s) shall be engaged and brought up to maximum pumping pressure with all agent applicator outlets closed. Observe and record pump discharge pressure.

(3) Adjust roof turret elevation to optimum range position, open roof turret discharge valve, observe range of turret stream, and continue flow to allow system pressure to stabilize and observe and record pressure.

(4) Continue turret discharge and initiate discharge from each of the following in its turn: auxiliary turrets and primary handlines (add one at a time). All applicators shall be discharging simultaneously in straight stream.

NOTE: As each additional applicator is turned on, the range of the initial turret stream and the initial range of each added appliance stream should be compared by observing the system pressure and, after system pressure stabilization, recording the pressure.

(5) Continue discharging with all applicators flowing until the system pressure has stabilized, then record pressure and stop test.

e. Pass/Fail Criteria.

(1) The discharge range shall show no signs of deterioration as additional applicators are engaged.

(2) The stabilized system discharge pressure shall not fluctuate by more than 10 percent when comparing the stabilized discharge pressure of the roof turret flowing by itself to the stabilized discharge pressure of the system with all appliances discharging simultaneously.

(3) Foam shall be evident in the discharge stream of all appliances at all times during the test.

130. GRADEABILITY.

a. Facilities.

(1) This test requires a site with a grade of at least 50 percent that is long enough to allow the vehicle to achieve a speed of 1 mph (1.6 kph) with all wheels still on the grade.

(2) If the optional simulated grade/draw bar pull method is used, a level, paved site is required that can accommodate the combined length of the vehicle and a load dynamometer sled while this vehicle combination achieves speeds up to 1 mph (1.6 kph).

b. Equipment Required.

(1) If the alternate draw bar pull method is to be used, a load cell accurate to within $\pm$ 500 lbs, (227 kg) and a variable load dynamometer sled will be needed.

(2) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the vehicle documentation package.

c. Test Conditions.

(1) The water and the foam tanks shall be full at the start.

(2) The vehicle shall be fully loaded with the tires inflated to the manufacturer's recommended operating pressure. Appropriate ballast shall be used as needed to account for the crew and equipment allowances.

(3) The vehicle engine(s) and transmission shall be at normal operating temperature.

d. Test Procedures.

TEST-1. On Grade. The vehicle shall be positioned on the flat at the bottom of the 50% grade, initiate ascent of the grade, and achieve a speed of at least

one mph (1.6 kph). Record the actual speed achieved.

TEST-1A. Alternate On Grade.

NOTE: If an actual 50 percent grade is not available, the vehicle may be coupled to a "50 percent grade equivalent" draw bar load. The load cell reading (in Unit Force per Unit Area) required to simulate the 50 percent grade must equal, (sin 26.57°) x (gross vehicle weight) divided by the (unit area of the load cell).

(1) With the vehicle coupled to the appropriate simulated grade, initiate the simulated ascent of the grade, continue the forward motion, and monitor the load cell readings until a speed of at least 1 mph (1.6 kph) is achieved.

(2) Record the load cell reading and the actual speed achieved.

e. Pass/Fail Criteria. The vehicle performance shall be acceptable if grade or the simulated grade is negotiated smoothly and safely and if the vehicle fulfills the standard requirements of paragraph 55.

131. PRESSURE TEST OF PIPING AND CONNECTIONS.

a. Facilities.

(1) This test requires an area that provides access to dry compressed air or nitrogen.

(2) The test area shall also provide sufficient clearance between the vehicle being tested and any other valuable property to prevent damage in the event of a pipe or fitting failure.

(3) The test area shall also provide for protection for the test personnel against possible flying debris from a component failure.

b. Equipment Required.

(1) A gauge suitable for the intended service with a an accuracy of $\pm$ 5 psi and a working range equal to 2.0 times the normal agent system operating pressure.

(2) A means of developing and delivering pressure equal to 1.5 times the normal agent system operating pressure.

(3) Miscellaneous plates, caps, and fittings suitable for isolating the suction side of the agent system if necessary and a suitable leak detection solution.

(4) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

NOTE: It is often easier and/or more convenient to perform this test before the vehicle body is completely assembled with the agent system controls in place. Therefore, the agent system does not have to be fully operational for this test.

(1) The agent system piping shall be fully assembled, i.e., no subsystem testing is permitted.

(2) All suction side piping components which cannot tolerate the test pressures shall be isolated from the discharge system.

(3) Agent pumps shall be included in the discharge system test.

(4) All agent discharge outlet valves shall be closed.

(5) All bypass lines from the discharge system to the water and foam concentrate tanks shall be blocked during the test.

d. Test Procedure.

(1) Pressurize the agent discharge system to at least 1.5 times the maximum recommended system operating pressure.

(2) Isolate the agent discharge system in the pressurized condition by closing the test pressure supply line inlet valve and lowering the supply device pressure.

(3) Record the pressure and monitor the system pressure for at least 30 minutes.

(4) If the pressure drops, the leaks shall be located and repaired and the test shall be repeated until the pressure can be maintained for at least 30 minutes.

(5) Upon completion of the test, remove any discharge/suction system isolation devices and reassemble the suction piping.

(6) The water and foam concentrate tanks shall be filled, and the suction piping shall be inspected for leaks during and immediately after the agent system has been operated in the foam/water solution discharge mode.

e. Pass/Fail Criteria.

(1) No pressure decay shall be permitted during the 30 minute pressure holding period.

(2) No leaks shall be permitted in the discharge or suction piping during or after agent system operation.

132. PUMP AND ROLL CAPABILITY.

a. Facilities. Same as for the Foam/Water Agent System Prototype Test; paragraph 107a(1), (2) and (4).

b. Equipment Required. Same as for the Foam/Water Agent System Prototype Test; paragraph 107b(2), (6) and (10).

c. Test Conditions.

(1) The vehicle agent system shall be fully operational.

(2) All foam/water applicator discharge system performance requirements shall have been previously verified by prototype tests as specified in paragraph 105.

(3) Same as for the Foam/Water Agent System Prototype Test; paragraph 107c(1) and (3) through (8).

d. Test Procedure. Same as for the Foam/Water Agent System Prototype, paragraph 107d, TESTS-11 and -12.

e. Pass/Fail Criteria. Same as for the Foam/Water Agent System Prototype, paragraph 107e(16) through (20), TESTS-11 and -12.

133. RADIO INTERFERENCE SUPPRESSION.

a. Facilities. Those specified in SAE J551 or an equivalent standard approved by the authority having jurisdiction.

b. Equipment Required.

(1) That specified in SAE J551 or an equivalent standard approved by the authority having jurisdiction.

(2) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) All electrical devices required by this specification shall be mounted on the vehicle and shall be operational.

(2) The vehicle engine(s) shall be operating at idle.

(3) All vehicle lighting shall be on.

(4) All heat, defrost, and air conditioning systems shall be operating with their respective fans operating at maximum speed.

(5) If provided, auxiliary power generating devices shall be running.

(6) All intermittent warning devices, such as overheat, low pressure or fluid level, high temperature, vehicle backing warning buzzers; hazard flashers, sirens, and horns shall be turned off.

(7) All other vehicle mounted electrical devices normally functioning at an accident site shall be turned on.

d. Test Procedure.

(1) The procedures required by SAE J551 or the equivalent standard shall be used.

(2) The test results shall be recorded and evaluated in accordance with SAE J551 or the equivalent test standard.

e. Pass/Fail Criteria. The radio interference suppression shall be acceptable if it meets the requirements of SAE J551 or the equivalent standard.

134. ROOF TURRET DISCHARGE RATE.

a. Facilities. Same as for the Foam/Water Agent System Prototype, paragraph 107a(1) and (4), TEST-9 or -9A.

b. Equipment Required. Same as for the Foam/Water Agent System Prototype, paragraph 107b(2), (3), (4), (7), (8) and (10), TEST-9 or 9A, .

c. Test Conditions.

(1) The vehicle agent system shall be fully operational.

(2) All foam/water applicator discharge system performance requirements shall have been previously verified by prototype tests as specified in paragraph 105.

(3) Same as for the Foam/Water Agent System Prototype, paragraph 107c(1) and (3) through (8), TEST-9 or -9A.

d. Test Procedure. Same as for the Foam/Water Agent System Prototype, paragraph 107d, TEST-9 or -9A.

e. Pass/Fail Criteria. Same as for the Foam/Water Agent System Prototype, TESTS-9 or -9A, paragraph 107e(14).

135. SIREN SOUND OUTPUT: DIRECTION AND

MAGNITUDE.

a. Facilities. This test requires a flat open area where it is acceptable to generate a loud noise for an extended period of time. The area shall not have any large reflecting surfaces, such as other vehicles, storage tanks, hills, signboards or buildings within a 200-foot (60 m) radius of the test vehicle.

b. Equipment Required.

(1) A tape measure suitable for measuring 100 feet (30 m) with an accuracy of $\pm$ 1 inch and a protractor with an accuracy of $\pm$ 1 degree.

(2) A sound level meter calibrated within the past 12 month period by a certified testing laboratory. The meter shall meet the requirements of the American National Standards Institute's Standard, ANSI SI.4-1971, for Type 2 Sound Level Meters.

(3) Sufficient sets of approved ear protection devices for all test personnel.

(4) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions. The vehicle siren/siren speaker shall be mounted in its normal location and be fully operational.

d. Test Procedure.

(1) Measure and mark the locations for three listening posts as follows:

(a) The first shall be at 45 degrees to the left of the longitudinal centerline of the vehicle and 100 feet (30 m) from the left corner of the front bumper.

(b) The second shall be on the centerline and 100 feet (30 m) in front of the front bumper.

(c) The third shall be 45 degrees to the right of the centerline and 100 feet (30M) from the right corner of the front bumper.

(2) The sound level meter shall be set to the "A-weighing network, fast meter response."

(3) Place the sound level meter at one of the listening posts with the microphone located 5.5 feet (1.65 m) above the ground.

(4) Activate the siren and record the meter reading.

(5) Repeat steps (2) through (4) at the other two listening posts.

e. Pass/Fail Criteria. The siren shall be acceptable if the recorded sound levels meet or exceed the standards of paragraph 7a(1)-(3).

136. STABILITY: DYNAMIC AND STATIC.

a. Facilities for Stability Test Series.

(1) Test-1 requires a level, dry, paved surface at least 250 feet (75 m) in diameter free from loose material. A 100-foot (30 m) radius circle that can be seen and followed by the vehicle driver shall be marked on the surface.

(2) Test-2 requires a tilt table or other suitable surface capable of being tilted on which the entire vehicle can be placed. An acceptable alternative is the use of a fixed grade that is equal to the slope requirement for the class vehicle being tested.

(3) Test-2 requires a means to restrain the vehicle at the balance point.

b. Equipment for Test Series.

(1) A calibrated speedometer.

(2) A means of measuring steering wheel cramp angle.

(3) An inclinometer capable of measuring the slope of the vehicle or the support surface during the tilting procedure with an accuracy $\pm$ 0.5 degrees.

(4) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be fully loaded. Ballast shall be used as needed to account for the crew and equipment allowance. The ballast shall be arranged to distribute the weight in a manner that closely simulates the items being represented.

(2) The ballast shall NOT be shaped or distributed in a manner that creates a favorable, artificial center of gravity.

(3) If the vehicle is equipped with a high-reach, extendable turret, it shall be retracted and secured in its stowed position during these tests.

d. Test Procedure.

TEST-1. Dynamic Turning Control.

(1) The vehicle shall be driven at less than 1 mph (1.6 kph) around the 100 ft. (30 m) radius circle while keeping the centerline of the front of the vehicle approximately over the marked circle. After the driver has stabilized the vehicle on this path, a reference mark shall be placed on the steering wheel cramp angle indicator, and the actual speed shall be recorded.

(2) The vehicle speed shall be increased gradually until the maximum safe speed, judged by the driver, is reached. Record the actual speed and steering wheel cramp angle.

(3) Repeat steps (1) and (2) while driving the vehicle in the opposite direction.

TEST-2. Static Side Slope Stability--Tilt Table.

(1) Tilt the tethered vehicle to an angle at least equal to the side slope angle specified in Table 2, performance parameter 2, applicable to vehicle class.

(2) Once the vehicle is at the required angle, check the tether lines for tension. If there is tension reduce the angle until the tension is relieved and record the actual angle achieved.

TEST-2A. Optional Procedure--Fixed Grade Alternative.

NOTE: Before attempting this alternative means of testing side slope stability, the operator should have a high degree of confidence that the vehicle can perform at the required angle. Preliminary tests on lower slopes is strongly advised. A reliable vehicle restraint system that can function while the vehicle is being positioned on the required slope shall be used.

(1) Position the tethered vehicle on a grade having an angle above the horizon at least equal to the standard side slope angle in Table 2, performance parameter 2, applicable to the vehicle.

(2) Once the vehicle is at the required angle, check the tether lines for tension and record the results.

e. Pass/Fail Criteria.

(1) The dynamic turning control of the vehicle shall be acceptable if it meets the criteria of paragraph 53, the standard in Table 2, performance parameter 3 for the applicable vehicle class, and the steering angle required to keep the vehicle on the circular path shall **NOT** decrease at any time with increasing speed (i.e. oversteer characteristics are unacceptable.)

(2) The static side slope stability of the vehicle shall be acceptable if it can stand on the applicable standard grade specified in Table 2, performance parameter 2, with NO perceptible tension on the tether lines.

137. STEERING SYSTEM: RESISTANCE AND TURNING DIAMETER.

a. Facilities for Test Series. These tests require a dry, level, paved area that is free from loose material and is larger in all directions than three times the length of the vehicle being tested.

b. Equipment Required.

(1) A steering wheel torque meter, a spring scale, or another means of measuring the force applied to the steering wheel rim with an accuracy of $\pm$ 2 percent of the value being measured.

(2) A set of wheel chocks.

(3) A device suitable for measuring three times the length of the vehicle being tested with an accuracy of at least $\pm$ 1 inch.

(4) Markers or marking device suitable for marking the pavement.

(5) A plumb bob or other device suitable for locating a point on the pavement directly below a fixed point on the vehicle.

(6) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be fully loaded. Ballast shall be used as needed to account for the crew and equipment allowance. The ballast shall be arranged so as to distribute the weight in a manner that closely

simulates the items being represented. The ballast shall NOT be shaped or distributed in a manner that creates a favorable, artificial center of gravity.

(2) The vehicle steering system shall be fully operational, and the steering linkage stops shall be adjusted to the manufacturer's specified production tolerance limits.

d. Test Procedure.

TEST-1. Resistance or Operating Force Requirements.

(1) With wheel chocks under one set of non-steering wheels, set the steerable wheels in the straight ahead position, start the engine, engage neutral and release the brakes. Ensure that the vehicle does not roll.

(2) With the engine at idle speed, measure and record the forces needed at the steering wheel rim to move the steering linkage from center to full left and full right stops. Also measure and record the force required to move the steering wheel from full left stop to full right stop and visa versa.

TEST-2. Wall-to-Wall Turning Diameter.

(1) The vehicle shall be driven slowly in a full left or right cramp circle, to establish a steady state in the steering linkage.

(2) Continue driving the slow full cramp circle.

(3) At three approximately equidistant points, (identified as A, B, and C) around the circle, gently stop the vehicle using the service brakes.

(4) At each stop, place a plumb bob against the outermost point of the vehicle and mark the spot on the ground directly below where the plumb bob comes to rest.

(5) Measure and record the straight line distances between each pair of points, e.g., Lengths AB, BC, and CA.

(6) Calculate the wall-to-wall turning diameter (D) as follows:

Where: $D = 2R$

and $S = \text{Length}, \frac{[AB + BC + CA]}{2}$.

$$D = 2R = \frac{AB \times BC \times CA}{2\,[\,S\,(\,S-AB)\,(\,S-BC\,)\,(\,S-CA\,)]^{1/2}}$$

(7) Repeat steps (1) through (6) with the vehicle moving in the opposite direction.

e. Pass/Fail Criteria.

(1) The steering system operating forces shall be acceptable if they meet the standards specified in paragraph 33a and b.

(2) The steering turning radius shall be acceptable if it meets the wall-to-wall turning diameter (D or 2R) standard specified in paragraph 33d and Table 2, performance parameter 8.

138. TOP SPEED.

a. Facilities. This test requires a dry, straight, level, paved surface of sufficient length to accelerate the vehicle to 65 mph (104 kph) and to bring it to a safe rapid stop. Sufficient space is needed at each end to turn and re-position the vehicle for a return run.

b. Equipment Required.

(1) The vehicle speedometer and tachometer as installed.

(2) A test report notebook or similar record forms to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) Elevation between sea level and up to 2,000 Ft. (600 m) unless otherwise specified by the purchaser.

(2) The vehicle shall be fully loaded to include ballast as appropriate for the crew and equipment allowance.

(3) The engine(s) and the transmission(s) shall be at normal operating temperature.

(4) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

d. Test Procedure.

(1) Start with the vehicle at rest, the engine at idle, and the transmission in gear.

(2) Begin accelerating the vehicle and continue accelerating until the vehicle reaches at least 65 mph (104 kph). Record the speed actually achieved.

(3) This test sequence should be repeated in the opposite direction to cancel the effects of wind and slope. At least two readings in each direction shall be taken to calculate the reported average top speed.

e. Pass/Fail Criteria. The reported average top speed shall be acceptable if it meets or exceeds the standards specified in paragraph 57.

139. UNDERBODY CLEARANCES.

a. Facilities. This test requires a dry, level, paved area that is free from loose material and large enough to accommodate the vehicle being tested.

b. Required Equipment.

(1) A device suitable for measuring the vehicle length with an accuracy of ± 0.25 inches (63 mm).

(2) A large protractor suitable for measuring angles with an accuracy of ± 0.5 degree.

(3) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be fully loaded. Ballast shall be used as needed to account for the crew and equipment allowance. The ballast shall be arranged so as to distribute the weight in a manner that closely simulates the items being represented. The ballast shall NOT be shaped or distributed in a manner that creates a favorable, artificial center of gravity.

(2) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

d. Test Procedure.

(1) The vehicle shall be positioned on the test area and the following dimensions shall be measured in accordance with their definitions stated in Appendix 1:

(a) angle of approach,

(b) angle of departure,

(c) interaxle clearance angle,

(d) under-body clearance, and

(e) under-axle clearance.

(2) The results of the linear dimensions shall be rounded down to the nearest 0.5 inches (1.25 cm) and recorded.

(3) The results of the angular dimensions shall be rounded down to the nearest degree and recorded.

e. Pass/Fail Criteria. The underbody clearances shall be acceptable if they meet the standards of Table 2, performance parameters 4 through 7 for the applicable vehicle class.

140. VEHICLE INTERIOR NOISE LEVEL.

a. Facilities. This test requires that the vehicle be parked at a location so that no large reflecting surfaces such as other vehicles, signboards, buildings, or hills are within 50 feet of the driver's seating position.

b. Equipment Required. A sound level meter meeting the requirements of the American National Standards Institute's Standard, ANSI S1.4-1971 specification for Sound Level Meters, for Type 2 Meters.

c. Test Conditions.

(1) If the engine radiator fan drive is equipped with a clutch or similar device that automatically reduces the rotation speed of the fan or completely disengages the fan from its power source in response to reduced cooling loads, the vehicle may be parked before testing with its engine running at high idle or any other speed the operator may choose for sufficient time but not more than 10 minutes to permit the radiator fan to automatically disengage.

(2) Park the vehicle in a location that meets the criteria of paragraph a.

(3) The driver shall be in the normal seated position at the vehicle's controls.

(4) No other occupants, except the person conducting the test, shall be in the cab during the test.

d. Test Procedure.

(1) Set the sound meter to the `A-weighting network, "fast" meter response.'

(2) Locate the microphone 6 inches to the right of, and directly in line with the drivers right ear.

(3) If the engine is equipped with a governor, put the transmission in neutral, and accelerate the engine to the maximum governed speed; **OR** if it is not equipped with an engine governor, accelerate to the speed for maximum rated horsepower. Stabilize the engine at that speed.

(4) Observe the "A-weighted" sound level reading on the meter for the stabilized engine speed condition. If the reading is not being influenced by extraneous noise sources such as motor vehicles operating on adjacent roadways, record that reading.

(5) Reduce engine speed to idle and repeat the procedures specified in paragraphs d(3) and (4) above until two maximum sound levels within 2 dB of each other are recorded. Numerically average the two maximum sound level readings, and report the result as the vehicle's interior sound level at the driver's seating

position.

e. Pass/Fail Criteria. The interior vehicle noise level shall be acceptable if the average noise level measured in accordance with the procedures above meets the criteria of paragraph 28e. A 2-dB tolerance over that noise level limitation is permitted to allow for variations in test conditions and variations in the capabilities of meters.

141. VISIBILITY: INCLUDED ANGLES FROM DRIVER'S SEAT.

a. Facilities. This test requires a level site located in a dimly lighted or heavily shaded area that is at least 20 ft. (6.1 m) longer and 40 ft. (12m) wider than the vehicle to be tested. Testing may also be performed in the low light of early morning or late evening hours.

b. Equipment Required.

(1) A device suitable for measuring distances up to 50 ft. (15 m) with an accuracy of $\pm$ 0.25 inch (63 mm).

(2) A large protractor suitable for measuring angles with an accuracy of $\pm$ 0.5 degree.

(3) A plumb bob or other device suitable for establishing a vertical reference point.

(4) A small, sharply focused light source, such as, flashlight, electric pointer, or other light source suitable for establishing the "line of sight" under the available test light conditions.

(5) A device capable of holding the light source that can be adjusted vertically and horizontally to serve as the simulated driver eye location on the driver's seat.

(6) A test report notebook or similar record form to be used as a test report work sheet and incorporated into the documentation package.

c. Test Conditions.

(1) The vehicle shall be fully loaded. Ballast shall be used as needed to account for the crew and equipment allowance. The ballast shall be arranged to distribute the weight in a manner that closely simulates the items being represented. The ballast shall NOT be shaped or distributed in a manner that creates a favorable, artificial center of gravity.

(2) The tires shall be inflated to the manufacturer's recommended cold inflation pressure.

d. Test Procedure.

(1) The driver's seat shall be adjusted to its mid-position with respect to top surface height and the fore and aft adjustment and have approximately 175 lbs (80 kg) on the seat. The rake of the seat back shall be adjusted to the vertical.

(2) The eye location device shall be placed in the driver's seat and adjusted to locate the simulated focal point 31 3/4 inches (80 cm) above the seat surface and 6 inches (15 cm) in front of the vertical plane of the front surface of the seat back.

(3) The upper and lower limits of the line-of-sight in the forward direction shall be identified by moving the light beam in the vertical direction until it just touches those obstructions.

(4) Measure and record the angle above and below the straight ahead focal plane where vision first becomes obstructed.

(5) Measure and record the distance along the ground from a point directly below the front surface of the front bumper to the point on the ground that is intersected by the light beam at the lowest angle of visibility.

(6) Restrictions to the extreme left and right lines of sight shall be identified by moving the light beam in the horizontal direction until it just touches those obstructions.

(7) Measure and record the angles left and right of the straight ahead line of sight where vision first becomes obstructed.

(8) At the extreme left and right visibility limits, measure and record the angle below the horizontal focal plane where downward vision first becomes obstructed.

(9) At the extreme left and right visibility limits, measure and record the distance along the ground from the point directly below the vehicle surface which is on the line of sight to the point on the ground that is intersected by the light beam at the lowest angle of visibility.

(10) Repeat step nine as necessary to establish a reasonably smooth arc of visibility between the extreme left point, the center point established in step six, and between the center point and the extreme right point.

e. Pass/Fail Criteria. Driver visibility from the cab shall be acceptable if it meets the standards of paragraph 28d(1) through (5).

APPENDIX 1. DEFINITIONS

A-1-1. INTRODUCTION.

1. Aircraft rescue and fire fighting (ARFF) is a relatively new branch of the fire fighting profession. There are approximately a million paid, part-time, and volunteer fire fighters in the United States and Canada. Thousands of new members, who are unfamiliar with the basic fire service terminology, join the ranks each year. The unique terms used by airport fire fighters in the performance of their duties further complicates the communications problem. Because of the small number of fire fighters at most civil airports, airport/community disaster plans and the various mutual aid arrangements must involve many traditional structural fire fighters. In order to work together effectively, these mixed forces must understand each other.

2. It is recognized that many geographical and technical dialects exist among fire service personnel and consultants. Hence, the terms in this appendix were assembled from a variety of individuals and institutions. A special effort was made to observe precedence in usage. Where a recognized authority, such as the International Civil Aviation Organization, the National Fire Protection Association, the National Transportation Safety Board, the Federal Aviation Administration, the structural fire service, or a specific equipment industry, has historically used a word or phrase with a widely accepted meaning, it was adopted for use in this guide specification and/or is included in this appendix to encourage universal use and to enhance understanding.

3. No attempt has been made to include words which are clearly understood by qualified fire fighters and non fire fighters alike or the many unique words that seem to be related only to structural fire fighting activities. Instead, the list is limited to the words and phrases which are most definitive of ARFF activities and vehicles.

A-1-2. DEFINITIONS.

1. Acceptance Tests. Tests conducted on every vehicle by the manufacturer to assure that:

(a) each vehicle is fully operational when delivered; and,

(b) the original level of performance verified by the prototype vehicle tests continues.

2. AFFF. See Aqueous Film Forming Foam Concentrate.

3. Aggressive Tire Tread. Tread designed to provide a maximum of traction for most types of service.

4. Air-Cooled Engine. One in which removal of waste heat from the cylinder walls is by direct transfer to the atmosphere by a moving air stream.

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

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

7. Ambient Temperature. The temperature of the environment surrounding a vehicle at any given time.

8. Angle of Approach or Departure. Describes the steepest ramp that a fully loaded vehicle can approach and ascend or descend and depart from a connecting horizontal surface without interference from any part of the vehicle. It is the angle bounded by the horizontal ground line and the line tangent to the loaded radius of the front/rear tire and the first structural part or vehicle accessory that it encounters as the angle increases above the horizontal.

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

10. Aqueous Film Forming Foam (AFFF) Concentrate. A concentrated aqueous solution of fluorinated surfactants and foam stabilizers which, when mixed with water in designated proportions, is capable of producing an aqueous fluorocarbon film on the surface of hydrocarbon fuels.

11. Authority Having Jurisdiction. The organization, office, or individual responsible for "approving" equipment, an installation, or a procedure.

12. Automatic Locking Differential. A type of non slip differential that operates automatically.

13. Axle Tread. The distance between the center of two tires or wheels on the opposite ends of one axle.

14. Bogie. A tandem arrangement of aircraft or ground vehicle wheels and axles. The bogie axles can move semi-independently, so that all wheels follow the ground as the attitude of the aircraft or vehicle changes or the ground surface changes. For example, in a 6 x 6 vehicle, where there are two axles at the rear of the vehicle to support the weight on the rear, this two-axle combination is the "rear bogie." An 8 x 8 vehicle with two axles on each end would have a front bogie and a rear bogie.

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

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

17. Combined Agent Vehicle. An ARFF vehicle which carries foam/water as the primary extinguishing agent and either a dry chemical, Halon

1211, or another acceptable agent as the complimentary agent. A "dual agent" vehicle is one designed so that the turret and/or handline can separately or simultaneously discharge both primary and complimentary agents.

18. Component Manufacturer's Certification. A signed application approval furnished by the manufacturer certifying that the component in question is acceptable as being:

(a) properly installed,

(b) suitable for service in the vehicle for its intended use, and

(c) in compliance with the respective construction criteria required by the applicable standard.

19. Coolant Preheater Device. A device for heating the engine coolant so that the engine maintains a constant temperature. It usually consists of a coolant jacket and an electric heating element. The engine coolant flows through the preheater jacket and absorbs heat from a heating element. Since the heating element obtains its power from an independent source, it can hold the engine coolant at a temperature recommended for fast starting.

20. Critical Rescue and Fire Fighting Access Area. The rectangular area on an airport surrounding any runway within which historical data has shown that most aircraft accidents can be expected to occur. The National Fire Protection Association describes it as "...the rectangular area surrounding any runway within which most aircraft accidents can be expected to occur on airports. It's width extends 500 ft (150 m) from each side of the runway centerline and it's length includes the runway plus 3,300 ft (1,000 m) beyond each runway end."

Area in Ft^2 = 1000 ft x [runway length(ft) + 6,600 ft]

OR

Area in m^2 = 150 m x [runway length(m) + 2,000 m]

21. Dual Agent Nozzle or Turret. A fire fighting appliance designed to dispense foam and a complimentary agent, individually or simultaneously.

22. Eductor. A device designed to proportion liquid foam concentrate into a foam/water system. The device may be part of a vehicle foam agent system or it may be portable.

23. Film Forming Foam. A foam liquid concentrate which, when mixed in appropriate proportions with water and applied to the surface of a flammable liquid, forms a film on the surface of the fuel that suppresses vaporization with or without the presence of visible foam.

24. Fluid Coupling. A turbine-like device which transmits power solely through the action of a fluid in a closed circuit, (i.e., no direct mechanical connection between input and output shafts) and without torque multiplication.

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

26. Foam Expansion Ratio. The number used to expresses the relationship between the volume of foam produced and the volume of water/foam solution used in its production.

27. Foam Liquid Concentrate Percentage. The numerical designation of the amount of foam-liquid concentrate in solution with water.

28. Fully Loaded Vehicle. The fully assembled vehicle, complete with a compliment of crew, fuel, equipment, and fire fighting agents. The crew allowance shall be 175 pounds (90 kg) per seating position. Unless otherwise specified, the equipment allowance is a maximum of 1,000 pounds (450 kg). Where the customer specifications require carrying more equipment, the actual weight of the equipment is also part of the GVW for performance tests.

29. 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, i.e., a fully loaded vehicle.

30. Interaxle Clearance Angle (Ramp Angle). Describes the sharpest "height of land" over which a vehicle can pass without hanging up. Clearance is determined by the angles formed by the horizontal ground line between the closest forward and rear axles and whichever of the following lines form the smallest angle:

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

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

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

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

33. Listed. Equipment or materials included in a list published by an organization (acceptable to the

"authority having jurisdiction") concerned with product evaluation. The organization performs periodic inspection of production items of the listed equipment or materials. Its listing states either that the equipment or materials meet appropriate standards or pass tests and, as a result, has been found suitable for use in a specified manner.

34. May. This term states a permissive use or an alternative method to meet a specified requirement.

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

36. Off-Pavement Performance. This refers to a vehicle's ability to perform or operate on other than paved surfaces. This "other than paved surfaces" includes dirt roads, trails, and a wide variety of open cross-country terrain. Other references to this capability may be in terms of "off-road mobility" or "cross-country mobility." These three terms are synonymous.

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

38. Percent Grade. The ratio of the change in elevation (rise) to the horizontal distance (run) traveled multiplied by 100. Example: A change in elevation of 50 feet (15 m) over a horizontal distance of 50 feet (15 m) is a 100-percent grade. This is also known as a 45-degree angle or 1:1 slope.

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

40. Protein Foam Concentrate. A concentrated solution of hydrolyzed protein plus stabilizing additives and inhibitors to protect against freezing, to prevent corrosion of equipment and containers, to resist bacterial decomposition, to control viscosity, and to otherwise assure readiness for use.

41. Prototype Vehicle. The first of a unique vehicle configuration built to establish the performance capability, not only of itself, but of all subsequent vehicles manufactured from the same basic drawings and parts list. A given chassis, body, and fire fighting system and fully loaded weight condition shall constitute a vehicle configuration. Product improvements and/or customer options shall negate a previously conducted prototype test only if the changes can be reasonably expected to materially affect the performance.

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

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

44. Shall. Indicates a mandatory requirement.

45. Should. This term indicates a recommendation or advice but not a requirement.

46. Steering Drive Ends. The ends/stub shafts in the wheel spindle in a driving-steering axle used on the steering axle(s) of an all-wheel drive ARFF vehicle.

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

48. Ton. This unit equals 2,000 U.S. pounds (907 kg).

49. Twenty-Five Percent Drainage Time. The time, in minutes, that it takes for 25 percent of the total liquid contained in a known volume of foam to drain out. It is one means of evaluating the performance of foam producing devices. NFPA 412, Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles, gives a method of measuring drainage time.

50. Underbody or Under Chassis Clearance. The minimum dimension between the ground and any components of the vehicle except those that are part of the axle assemblies, which could hinder the passage of the vehicle. This dimension is determined with the vehicle fully loaded and fully equipped, unless otherwise specified.

51. Unitized Rigid Body and Frame Structure. A form of vehicle construction that integrates parts (generally comprising a separate body) with the chassis frame to form one rigid, load-carrying structure.

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

53. Vehicle Drive Nomenclature. Common vehicle references are 4 x 2, 4 x 4, 6 x 6, and 8 x 8. In the use of this nomenclature, the first number indicates the total number of wheels on the vehicle and the second number is the number of driving wheels.

54. Wall-to-Wall Turning Diameter. It is the smallest diameter circle described by the outermost point on the vehicle as it negotiates a 360-degree right or left turn.

55. Weather Tight. Compartment closure sufficient to prevent rain, snow, wind-driven sand, dirt or dust from penetrating under most operating conditions. It is not necessary to be watertight, vaportight, dust proof, or submersible.

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

APPENDIX 2. OFF-PAVEMENT MOBILITY

A-2-1. BACKGROUND.

1. There have been many attempts by individuals and institutions to identify the controlling parameters in the design of ARFF vehicles suitable for both paved and off-pavement service. While this capability is evasive, easily misunderstood, and expensive to achieve, it is a necessary one.

2. To be convinced of the need for good off-pavement performance, review the available aircraft accident statistics. For example, when past accident locations are mapped (see Figure A-2.1) one can clearly see that a large per cent of the aircraft accidents occur off runways and off other paved surfaces. Hence, to be truly cost effective, ARFF vehicles require certain off-pavement mobility capabilities while retaining the general highway performance requirements.

3. In addition, a review of Figure A-2.2 supports the premise that the highest potential benefit in terms of reducing future aircraft accident deaths by fire can be obtained by achieving the capability to perform the ARFF service life safety mission in the off-pavement environment of the airport. This capability is most effectively achieved through two complementary efforts.

4. First, all airports should be surveyed to identify those areas which lie within the airport's "Critical Rescue and Fire Fighting Access Area" (CRFFAA) that can not be traversed by the existing fleet of straight-framed, wheeled vehicles. See Figure A-2.1. If the size and/or distribution of these non-traversable areas is small relative to the CRFFAA, the potential accident sites should have alternate access routes (permanent or seasonal as may be appropriate) preplanned to avoid the use of these non-traversable areas during an emergency response to the likely accident sites. The designated ARFF vehicle operators should then become familiar with the preferred alternate routes, have knowledge of the operational limitations of their specific vehicles, and have the opportunity to practice their off-pavement driving skills over the designated alternate routes.

5. If the action taken above still leaves the airports with relatively large sections of difficult terrain, e.g., low soil strength, grades over 10 percent, rocky areas, swamp lands, deep snow, or bodies of water, which lie inside the airport's CRFFAA, the ARFF system manager should consider the specification of an ARFF service vehicle other than the ordinary straight-frame, wheeled ARFF vehicles. Examples of such vehicles are: straight-frame tracked; articulating, wheeled or tracked; amphibious, air cushioned or a combination of these types.

6. The off-pavement performance characteristics of any ground supported vehicle depend on numerous factors. Although considerable progress has been made in the continuing effort to identify these factors and to design for the controlling parameters of off-pavement vehicle performance, there are still many with which to deal. Never-the-less, the following factors, while not all inclusive, have been identified as important considerations in specifying a vehicle for off-pavement ARFF operations. Primary among those factors identified are the capabilities of the driver; topography of the area and soil trafficability; the vehicle's total geometric, inertial, and mechanical characteristics as well as the tire selection.

7. It is no secret that ARFF vehicles with special mobility requirements or the adaption of unique vehicles for ARFF service is expensive. Therefore, any special vehicle performance criteria identified as a result of an assessment of the airport's off-pavement mobility requirements must be addressed in quantitative terms to the maxim extent possible. In other words, the purchaser should make it perfectly clear what the ARFF vehicle manufacturer is being asked to provide...before the bids are opened.

8. through 19. RESERVED

A-2-2. TIRE SELECTION.

20. Tire diameter, width, inflation pressure, and deflection (as related to the loads imposed) are important basic elements. The use of treads designed to provide traction, skid resistance, and self cleaning is an allied consideration.

21. To optimize vehicle performance characteristics, i.e., achieve the best combination of acceleration, speed, braking, and maneuvering capabilities for both on and off-pavement, both the vehicle and the tire manufacturers must have accurate information about the intended service environment.

22. When local conditions require high floatation, (sand, mud, snow, etc.) and good traction for off-pavement mobility, vehicle tires shall have a tread suitable to develop a drawbar pull of 0.4 times the vehicle weight on a level, clean, clay surface, (CL in USCS Soil Classification System) with a strength of 200 or greater Rating Cone Index (RCI) immediately after a 1/2 inch per hour rainfall intensity storm.

23. through 29. RESERVED

A-2-3. GENERAL TOPOGRAPHY AND SOIL TRAFFICABILITY.

30. The U.S. Army Corps of Engineers at the Waterways Experiment Station at Vicksburg, Mississippi, has, over a period of 30 years of testing, developed an approach to this multifaceted problem which assesses soil strength in terms of cone index (CI) and quantifies a variety of vehicle properties in a term they call the vehicle cone index (VCI). The CI/VCI comparison is then used as a method of estimating (quantitatively) the probability of a vehicle of given characteristics successfully operating

in a given off-pavement soil condition. Although not accepted by some ARFF vehicle manufacturers, the concept is certainly noteworthy.

31. Furthermore, it is strongly recommended that anyone planning to develop a specification for an ARFF vehicle pay particular attention to the uniqueness of the entire off-pavement environment at their specific airport. As discussed earlier, special attention should be given to the unpaved surfaces inside the CRFFAA. If there is any doubt about accident site accessibility due to questionable soil trafficability, a soil strength survey should be performed to determine the CI of proposed access routes. The survey should be conducted during the time of year when the strength of the soil involved is at its poorest. This additional effort could pay big dividends in terms of ARFF vehicle cost-effectiveness.

32. The VCI is a means of quantitatively determining a specific vehicle's soil strength requirement and comparing it to the measured soil strength (cone index). The calculated VCI number for the vehicle should be less than the measured CI in a particular situation to assure successful operation. Vehicles operating on different types of soil will exhibit different levels of traction performance. Therefore, separate computations are required to predict soil-vehicle performance for fine-grained and coarse-grained soils.

33. In general, the vehicle having the lowest VCI will have the highest probability of negotiating a given off-pavement condition. If, as a result of a soil strength survey, the VCI is going to be used as a selection criteria it must be clearly identified as a performance requirement item in the request for bids. And, the manufacturers should be required provide the VCI for their specific vehicle design as part of their bid response.

34. through 39. RESERVED.

A-2-4. GEOMETRIC, INERTIAL, AND MECHANICAL CHARACTERISTICS.

40. The performance characteristics, acceleration and top speed, required in Chapter 2, Section 7 and Table 2 are not, in and of themselves, very useful in the off-pavement environment. However, the power required to produce that performance has a second, equally important function. In a well designed vehicle, the same power needed to meet the acceleration and top speed requirements can also be used to maneuver in the off-pavement environment. The requirement for that power has been quantified in Paragraph 55. "Gradability" and should be specified in those terms, NOT in in terms of a specific horsepower engine.

41. The vehicle design features which produce unstable performance in the operational environment on paved surfaces, are magnified in the off-pavement situation. Hence, it must be emphasized that stability is a "must have" item in any ARFF vehicle. This characteristics has been quantified in terms of both static and dynamic stability in Paragraph 53.

42. It is also important that a vehicle intended for off-pavement service be designed to minimize the potential for getting hung up on obstacles commonly encountered in the intended operational environment. Although universal agreement may never be reached, a significant degree of standardization has been attained. Items of particular concern are: angles of approach, departure, and interaxle clearance; underbody and underaxle clearances, and wall-to-wall turning diameter. Quantified requirements for these items can be found in Table 3.

43. Specifying unique values for other physical, non-performance related features such as overall height, width, length, exact turning radius, or gross vehicle weight becomes very complex and, with very few unique exceptions, it contributes nothing to the enhancement of the vehicle's off-pavement mobility performance capability. In general these features are payload dependent. Put another way, before these dimensions/clearances can be optimized the specific payload characteristics must be identified. As the independent variable, payload tends to dictate the practical range within which such features can be specified. In addition, the final results is usually the byproduct of a specific manufacturers overall design approach; and, as a result are often proprietary in nature.

44. through 49. RESERVED

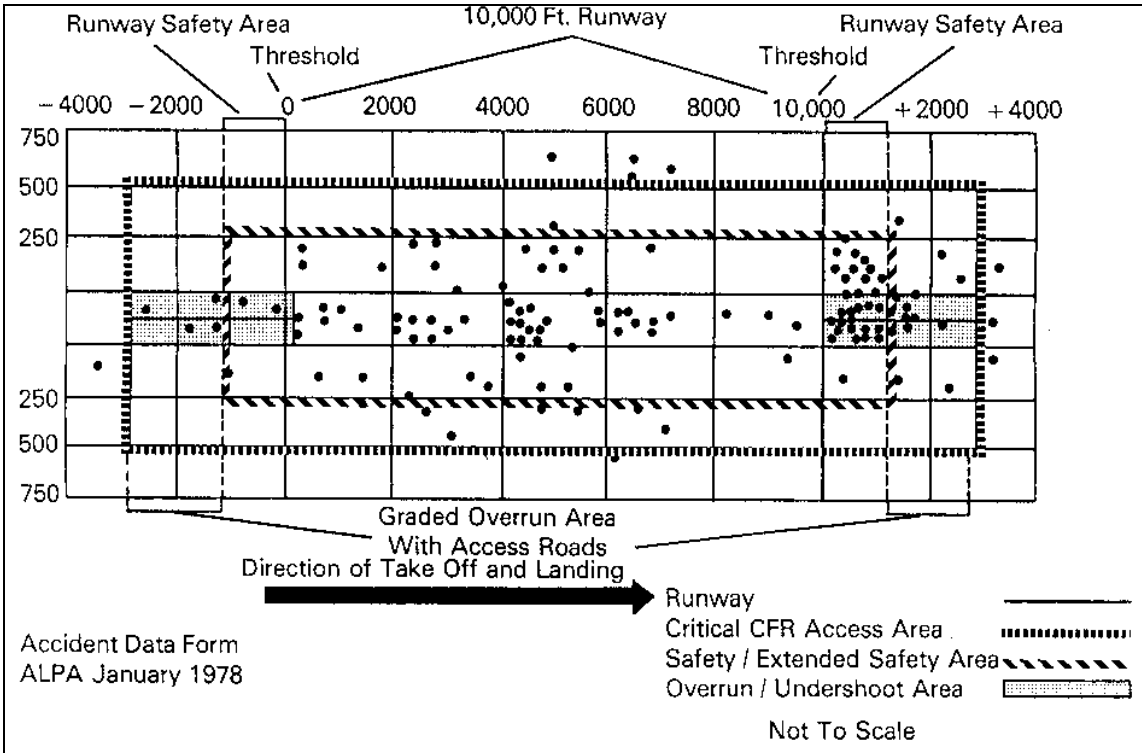

Figure A-2.1 Accident Site Locations and The Critical ARFF Access Area.

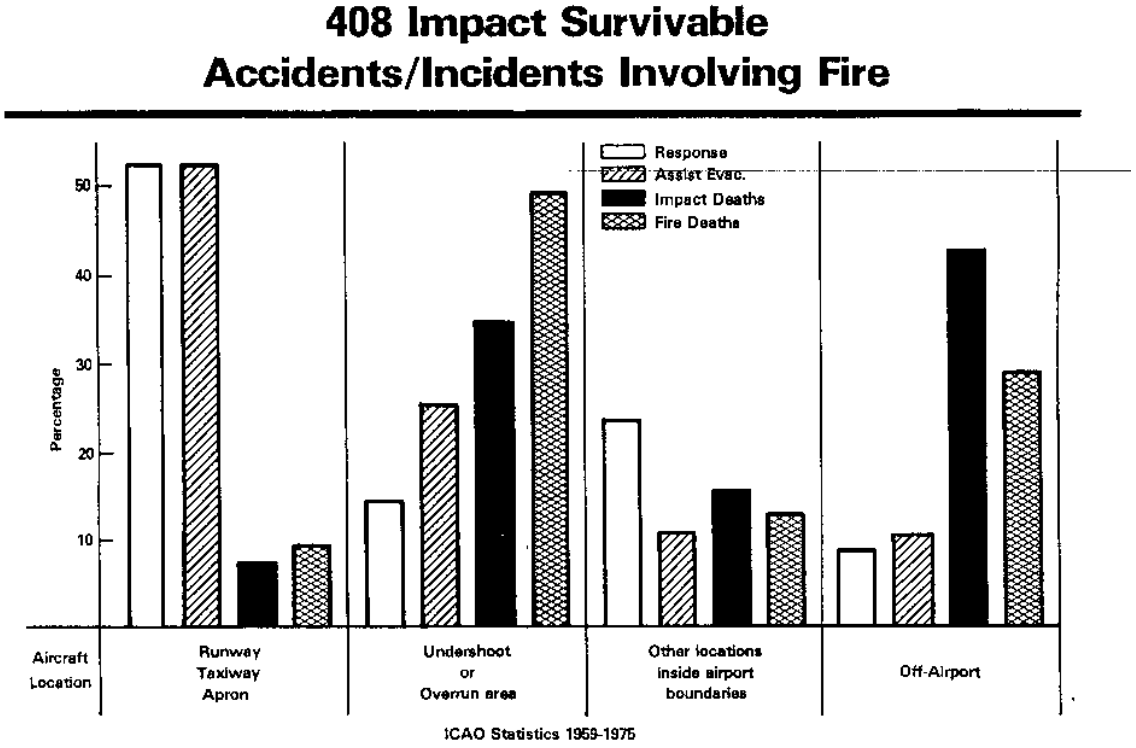

Figure A-2.2 Areas For Potential ARFF Operations.

APPENDIX 3. EQUIPMENT FOR AIRCRAFT RESCUE AND FIRE FIGHTING OPERATIONS

A-3-1. THE SELECTION PROCESS.

1. Aircraft rescue and fire fighting (ARFF) operations require a wide variety of both personnel safety and general use equipment and tools. The selection of a range of rescue equipment and tools that are both cost effective and appropriate for the ARFF equipment inventory at a given airport depends upon a number of considerations. For example:

a. Is the staffing both adequate and trained to actually make effective use of the item?

b. Are some or all of the more expensive, low-use items available from another source that can reasonably be expected to provide them in a timely manner through a mutual aid agreement?

c. If the necessary expertise is not available at the airport, can the equipment be operated by a mutual aid responder who is readily available and has the training necessary to participate effectively in ARFF operations on the airport?

d. Is the purchase of the needed items as part of the new ARFF vehicle package the most cost effective means of obtaining them? Frequently a local fire protection equipment supply company can provide a customized selection of the appropriate items at a better price than can a vehicle manufacturer who must first obtain the items from a similar source and then pass on the administrative costs.

e. Are special cabinet sizes and/or hold-down devices required to safely and securely store and transport some of the items selected? If so, these requirements are most cost effectively accommodated during initial construction.

2. Regardless of the source (new with the vehicle, new from an equipment supply company, or existing equipment to be transferred from an old vehicle) the decision as to what specific items are to be carried by a given vehicle should be made in advance of the purchase of a new vehicle. In addition, airports with more than one ARFF vehicle have the option to distribute the weight and bulk of the selected equipment among/between the available vehicles.

3. During the selection process, it should be kept in mind that where a rescue tool requires a power source for its operation, a decision must be made as to the means of providing it. For example:

a. Some pneumatic chisels, saws, and drills can operate from compressed-air cylinders or small internal combustion engines. These offer complete equipment mobility. However, with the latter, a minor risk in the form of a potential ignition source is introduced.

b. On the other hand, more complex rescue tools use pneumatic, hydraulic, or electrical power in sufficient quantities to require the support of stand-alone power units. This requires yet another decision, i.e., should vehicle-mounted power units with the range limitations imposed by the power cables be used or should portable power units be carried in the vehicle. The latter often require more personnel to operate effectively in the field.

4. through 19. RESERVED.

A-3-2. GENERAL USE EQUIPMENT, TOOLS, AND PERSONNEL PROTECTIVE EQUIPMENT. A list of recommended equipment is given in Table A-3-1. The range of equipment is broken out by both certificated airport ARFF Index and general aviation airports.

Table A-3-1. Recommended Equipment For Rescue Operations

	AIRPORT ARFF INDEX OR CATEGORY			
	GA-1	GA-2 & A	B-C	D-E
CHOCKS, 4 inch (10 cm) high	1	1	-	-
ROPE LINE, 50 Ft. (15 m) length	1	1	-	-
AXE, rescue, small non-wedge type	1	2	4	4
BLANKET, fire resistent	1	1	1	1
CUTTER, bolt 24 inch (61 cm), minimum length	1	1	1	1
CROWBAR, 36 inch (95 cm), minimum length	1	1	1	1
FLASHLIGHT or handlight w/charger	2	3	4	8
GLOVES, flame resistant (pairs) unless issued to individual crew members	2	3	4	8
HARNESS CUTTING TOOL	1	2	3	4
HOOK, grab or salving	1	1	1	1
HACKSAW, heavy duty with spare blades	1	1	1	1
MEDICAL KIT, first aid/first responder	1	1	1	1
* PROTECTIVE CLOTHING	*	*	*	*
PLIERS, side cutting 7 inch (17.8 cm)	1	1	1	1
PLIERS, slip joint 10 inch (25 cm)	1	1	1	1
SAW, powered complete with 2 spare blades OR CHISEL, pneumatic complete with spare air cylinder, chisel blade and retaining spring	1	1	1	2
SCREWDRIVER SET, assorted sizes & blade types	1	1	1	1
SKIN PENETRATOR -- AGENT APPLICATOR	1	1	1	2
SNIPERS, sheet metal straight cut	1	1	1	1
WRENCH, adjustable	1	1	1	1
** AIR CYLINDERS, SPARE (SCBA)	-	2	4	8
AXE, rescue, large non-wedge type	-	1	1	1
** BREATHING APPARATUS WITH CYLINDER, (SCBA)	-	2	4	8
CHISEL, cold 1 inch (2.5 cm)	-	1	1	1
FORCING TOOL, hydraulic or pneumatic	-	1	1	1
HAMMER, 4 pound (1.8 kg)	-	1	1	1
LADDER, extending (appropriate overall length)	-	1	2	2 or 3
CHOCKS, 6 inch (15 cm) high	-	-	1	1
CROWBAR, 5.5 Ft. (1.65 m)	-	-	1	1
ROPE LINE, 100 Ft. (30 m) length	-	-	1	1

* Approved protective clothing; complete sets (to include head, hand and foot protection) of a type appropriate to the fire fighting tasks to be performed, of the correct size and in sufficient numbers to provide all personnel who are expected to participate in ARFF activities with a set. See AC 150/5210-14 for guidance on protective clothing. Also see National Fire Protection Standard 1976-92, Standard on Protective Clothing for Proximity Fire Fighting.

** The quantities recommended are nominal. Managers of ARFF services should be aware that certain National Consensus Standards as well as State and Federal OSHA work place safety standards relating to fire fighting operations and the use of self contained breathing apparatus may be applicable to their jurisdiction. Hence, additional SCBA units may be required and special training and/or operator certification may be needed.

APPENDIX 4. PURCHASER ELECTION OF SUBSYSTEM COMPONENTS

A-4-1. BACKGROUND.

1. The Federal Aviation Administration, airport sponsors, and manufacturers of airport rescue and fire fighting vehicles, working together, have produced an ARFF vehicle guide specification based on quantifiable and verifiable performance criteria.

2. This guide specification (AC 150/5220-19, Guide Specifications for Small, Dual Agent Aircraft Rescue and Fire fighting Vehicles) is intended to permit manufacturers to bid competitively and to preclude the need for the purchaser to be involved in materials or component selection. However, it does contain an array of subsystem options which are clearly related to local operational criteria and vehicle cost-effectiveness. This array, when collected together, forms an option menu which gives purchasers the opportunity to tailor the performance of a new vehicle to "fit" the airport's identifiable operational needs in a cost-effective manner.

3. When followed closely, this guide specification will go a long way towards avoiding the continuous string of time consuming protests triggered by the "proprietary" or "exlusionary" nature of the request for bids seen in the past.

4. It should be noted that, with few exceptions, the specific means to fulfill the automotive and fire extinguishing subsystem performance criteria are not included in the menu. The "how to" details of vehicle fabrication are deliberately left to the prospective bidder.

5. through 19. RESERVED.

A-4-2. OPTION SELECTION WORKSHEET.

20. The guide specification provides numerous opportunities for the purchaser to make subsystem component/performance selections which effect the vehicle characteristics. A paragraph-by-paragraph list (menu) of those vehicle characteristics which are specifically reserved for the purchaser has been assembled in the form of a selection worksheet. A check list is provided in the right hand column of the worksheet on which the purchaser may indicate which of the available options are required to tailor the vehicle to the needs of his/her specific airport.

21. If a purchaser believes that additional items or modifications (including the selection of the means to fulfill the required performance now reserved for perspective bidders) are needed to fulfill local, **identifiable, operational requirements**, they should be added this list. These additional modifications must be accompanied by a detailed rational which clearly justifies departing from the performance orientated nature of the guide specification. Such requests will be evaluated and approved/rejected on a case-by-case.

AC Para. Number:	Paragraph Title or Subsystem Description:	Rationale for Allowing Purchaser Choice:	Purchaser's Selection:
Chapter 1. Introduction			
4e	Provisions for mounting radios.	The specific provisions for mounting radios is a function of the type, size, shape, and operational configuration of the radio in service at the airport or being ordered as part of the vehicle purchase. Therefore, it must be tailored to the individual airport's requirements.	Type and location of radio:
13d and 13c	Insulation and Waterproofing.	The need for AC and winterization are subject to both climatic/geographical and operational considerations which are airport specific.	Air Conditioning Required: Yes__ No __ Winterization Required: Yes__ No __
Chapter 2. Automotive System			
21b	Dimensions.	In the case of overall vehicle dimensions, there is the potential for conflict between the vehicle size in one or more of its dimension with the local operating environment. If this is not allowed for, it could reduce the overall cost effectiveness of the performance-based operational specification by either restricting flexibility or by requiring expensive facility modifications. A justification is required for each specific dimension that is requested.	Required specific dimensions: Length:_____ Height:_____ Width:_____ JUSTIFICATION:
26c	The election of a "pintle hook"in lieu	Towing other vehicles with an ARFF vehicle is not a common practice. However, some	Rear towing eyes:_____

of "two towing eyes"...	operators believe that the pintle hook enhances operational flexibility. The substitution of it for the two rear towing hooks/eyes, which are intended to facilitate ARFF vehicle recovery in the case of breakdown or a stuck vehicle, does not impact the vehicle's fire fighting performance or, to any great extent, its recoverability.	OR Pintle hook:_____

28a(1)	More than two crew positions...	The need to fit ARFF vehicles with more than the minimum two seats is seen as a local operational decision.	Number of seats:_____ JUSTIFICATION:
32a(3)	The means used to keep brake system air reservoir up to operational pressure...	The vehicle brake air system performance requirement is specified. Which of the two recognized methods used to keep the vehicle brake air pressure operational does not impact the "as-built" vehicle performance. However, it may impact its cost-effectiveness if the method used is not compatible with local resources. Hence, the means used to accomplish this system readiness task is viewed as a local operational decision.	On-board compressor:_____ OR House air fitting:_____
35e	Driver-operated selector to disengage all-wheel drive... EXCEPTION:...	Some airports have little or no requirement to drive off-pavement. Hence, the ability to disengage the all-wheel drive is seen as a means of enhancing the vehicle cost-effectiveness by reducing tire wear while operating on hard surfaces.	Permanent all-wheel drive:_____ OR Driver-operated selector:_____
37f	Provision of any special tools needed to service tire and wheel assembly...	If the special tools identified by the vehicle manufacturer are already available at the airport or if a tire service contract is used, it may be more cost-effective to request that the tools NOT be provided.	Provide special tools if any are required: YES_____ NO_____
39c(1) and	Optional lighting items...	These items of lighting equipment do not effect the vehicle performance and are not wanted by some operators. Hence, they are not required for the vehicle to be acceptable. Conversely, other operators believe these items are an operational requirement. This is particularly true at airports where there is no other source	Identify and list items being selected:

		for auxiliary on-site lighting. Hence, they are retained as optional accessaries that purchasers may request on an "as needed" basis.	
39c(2)	Addition of flashing amber (yellow) beacon...	A unique need that may be generated by a local operational requirement which does not effect the vehicle performance. Hence, it is permitted but is not be a universal requirement.	Add amber light: YES:_____ NO:_____

40d(1)	Mounting location for shore power plugs...	Although the location does not effect the vehicle performance, the local firehouse wiring configuration or personnel traffic patterns will dictate the most cost-effective or operationally advantageous location.	Identify & specify required location.
50	Winterization.	An expensive vehicle modification which may be needed to ensure operational readiness in some geographic locations and totally unnecessary in others. Purchaser is in best position to determine need.	Winterization required: YES:_____ NO:_____

Chapter 3. Fire Extinguishing Systems

Section 1.	Dry Chemical --Sodium or Potassium Bicarbonate Based **OR** Halon 1211 or an acceptable substitute -- Option	The Halon agent system is included as an option only to facilitate the purchaser's selection of the ARFF vehicle fleet agent configuration that best fits the operational situation. While fire service managers must comply with FAR Part 139 requirements, they must also comply with the the United States' obligation regarding the limited use of or the elimination of halon 1211 under the Montreal Protocol treaty.	Dry chemical required: YES:_____ NO:_____ Sodium: ___. Potassium: ___. Halon or sub required: YES:_____ NO:_____
Section 3. AND	Foam Concentrate System NOTE:....	The need for a separate foam/water or a premixed foam water solution system is a function of local operational procedures.	Separate foam/water system required: _____ Premixed foam/water system required: _____
Section 4.	Water System NOTE:....		
76a(1)	Concentrate Proportioner	The fire extinguishing performance for 6% and 3% foam concentrates is the same. However, cost-effectiveness and/or operational compatibility with mutual aid resupply sources may dictate the need for one or the other. Since proportioner performance is sensitive to the	Agent concentrate to be used in vehicle:
and (2)	...range of accuracy... for percent concentrate to be dispensed...		6% _____, 3% _____, OR

		concentrate, there is a need for the purchaser to identify which is to be used.	1% _____	
77c(1)	Concentrate Reservoir function of operational procedures. ...bottom fill...	The need for bottom fill capability is a function of operational procedures. However, the cost-effectiveness on small capacity tanks is very poor; therefore, its use is limited to the Class 3 vehicles.	Class 3 vehicle foam tank - bottom fill connection required: YES: ___. NO: ___.	and Piping.

78b	EXCEPTION: Adapters,...	Although there is a national standard for fire hose and hose connections, not all jurisdictions have completed the transition. Therefore, to ensure that the vehicle is compatible with local fittings and that effective mutual aid arrangements can be achieved, adapters for non standard fittings may be requested.	Adapters required: YES:_____ NO:_____ Identify specific type.
80a(2)	Water Reservoir and Piping... materials compatibility with local water characteristics.	This provision is not intended to put the purchaser into materials selection. However, it is intended to minimize the lifetime costs of vehicle ownership by alerting both the manufacturer and the purchaser of the need to identify the most likely sources of water to be used in the ARFF vehicle and to ensure that the properties of that water and the materials selected by the manufacturer for tank fabrication and the related piping are compatible.	Airport ARFF water supply has unusual characteristics: YES:_____ NO:_____ Identify unusual properties.
Section 5.	Pressurized, Premixed Foam/Water System. NOTE:...	The choice of pressurized or pump-driven, premixed foam/water solution system is clearly an operational decision. However, the practical upper limit on the volume for the premixed system is determined by the number and weight of the presurizing gas cylinders required to operate it. Conversely, the cost-effectiveness of pump driven premixed systems declines with the the reduction in agent tank volume.	Pressurized system required: ____. Pump-driven system required: ___.
84a _____	Twinned or separate water/foam and complementary agent handlines.	The method of mounting the handline does not affect the fire extinguishing performance. However, depending on the complementary agent chosen and/or the agent application tactics used at a specific airport, one method may be more cost-effective than the other.	Separate agent handlines: _____ OR Twinned agent handlines:
84b	Reeled handlines...	The inclusion of both types of handlines is	Reeled, hard rubber

and	OR	intended to provide the purchaser a choice that will be compatible with the airport fire department's operational requirements.	handlines: No: __ Yes: __ Length: __ OR
84c	Woven jacket handlines... Length: ___ Ft.		Woven jacket handlines in hose bed: No: __ Yes: __ Size: ___ In.
89	High-reach Turrets. --Option relating to turrets	The ability to elevate or extend the reach of the primary turret is a unique need that may be generated by a local operational requirement. Hence, it is a permitted option; not a requirement. Appropriate justification shall be provided. Include a detailed discription of the need for a "man rated" or a "non-man rated" device. Also include a clear indication of the airport's operational requirements and a discussion of the expected enhancements in safety and improvements in cost effectiveness.	A required operational need. YES:_____ NO:_____ Man-rated system: __ Nonman-rated syetem: __ JUSTIFICATION:

OTHER DEVIATIONS FROM THE GUIDANCE CONTAINED IN AC 150/5220-19 SHOULD BE LISTED BELOW BY PARAGRAPH NUMBER AND TOPIC. INCLUDE THE RATIONAL FOR THE REQUESTED DEVIATION.