23.1.2 Prior to the foam proportioner system test, all foam system components shall be inspected in accordance with Chapter 12.

23.2 Performance Level. The foam proportioner system shall be operated at the proportioning ratio specified by the AHJ and at the water flow and pressure for the agent(s) employed.

23.2.1 The system output shall be measured to determine calibration accuracy.

23.2.2 The system shall be operated at the same proportioning ratio, water flow, and pressure each time the system is tested.

23.3* Testing Methods. One of the following four methods for testing a foam proportioning system for calibration accuracy shall be used:

(1) Substituting water for foam concentrate
(2) Measuring foam concentrate pump output directly
(3) Determining foam percentage by use of a refractometer
(4) Determining foam percentage by use of a conductivity meter

23.4 Multiple Concentrate Systems. If the apparatus is equipped with multiple foam concentrates, the system shall be tested with each concentrate being carried.

23.5 Accuracy Level. Foam proportioner system accuracy shall meet the minimum requirements in effect at the time the proportioner system was installed.

Chapter 24 Performance Testing of Compressed Air Foam Systems (CAFS)

24.1 General. If the apparatus is equipped with a compressed air foam system (CAFS), a test shall be performed to determine if the compressed air system is capable of delivering the manufacturer's maximum recommended airflow at rated pressures.

24.2 Frequency. At a minimum, the compressed air system for CAFS shall be tested annually.

24.3 Inspection. Prior to testing the compressed air system for CAFS, all system components shall be inspected in accordance with Chapter 13.

24.4 Test Method.

24.4.1 All tests shall be conducted using either a calibrated airflow meter in conjunction with a standard cubic feet per minute (SCFM) flow chart, or a fixed orifice flowmeter in conjunction with various size of orifices to test the flow volume in SCFM *(see Table 24.4.1 for volume in SCFM for different orifice sizes and psi loss)*.

24.4.2 Test procedures shall be as follows:

(1) Run the compressed air system at the CAFS manufacturer's recommended maximum airflow at 125 psi (862 kPa) for 20 minutes.
(2) Record the airflow, air pressure, and compressor temperature at start up and in 5 minute increments.
(3) Record the maximum air pressure developed by the compressed air system.

Table 24.4 1 Volume of Air in Standard Cubic Feet per Minute (SCFM)

Pressure Loss Across Orifice (psi)	Orifice Diameter (in.)										
	1/64	1/32	1/16	1/8	1/4	3/8	1/2	5/8	3/4	7/8	1
5	0.062	0.249	0.993	3.97	15.9	35.7	63.5	99.3	143	195	254
7	0.073	0.293	1.17	4.68	18.7	42.2	75.0	117	168	260	300
9	0.083	0.331	1.32	5.30	21.2	47.7	84.7	132	191	260	339
12	0.095	0.379	1.52	6.07	24.3	54.6	97.0	152	218	297	388
15	0.105	0.420	1.68	6.72	26.9	60.5	108	168	242	329	430
20	0.123	0.491	1.96	7.86	31.4	70.7	126	196	283	385	503
25	0.140	0.562	2.25	8.98	35.9	80.9	144	225	323	440	575
30	0.158	0.633	2.53	10.1	40.5	91.1	162	253	365	496	648
35	0.176	0.703	2.81	11.3	45.0	101	180	281	405	551	720
40	0.194	0.774	3.10	12.4	49.6	112	198	310	446	607	793
45	0.211	0.845	3.38	13.5	54.1	122	216	338	487	662	865
50	0.229	0.916	3.66	14.7	58.6	132	235	366	528	718	938
60	0.264	1.06	4.23	16.9	67.6	152	271	423	609	828	1082
70	0.300	1.20	4.79	19.2	76.7	173	307	479	690	939	1227
80	0.335	1.34	5.36	21.4	85.7	193	343	536	771	1050	1371
90	0.370	1.48	5.92	23.7	94.8	213	379	592	853	1161	1516
100	0.406	1.62	6.49	26.0	104	234	415	649	934	1272	1661
110	0.441	1.76	7.05	28.2	113	254	452	705	1016	1383	1806
120	0.476	1.91	7.62	30.5	122	274	488	762	1097	1494	1951
130	0.494	1.98	7.90	31.6	126	284	503	790	1138	1549	2023

Notes:
(1) SCFM = 0.028 standard cubic meters per minute (SCMM); 1 psi = 6.895 kPa; 1 in. = 25.40 mm.
(2) Values calculated based on dry air at atmospheric pressure of 14.7 psi (101.4 kPa), 70°F (21°C).

(4) Connect one 100 ft (30 m), 1½ in. (38 mm) or smaller hoseline to a CAFS discharge and stretch it out on level ground.
(5) Secure the nozzle end of the hoseline to a stationary object with rope, with straps, or in some other manner such that when the nozzle is opened as specified in 24.4.2(10) the operator is protected from nozzle movement.
(6) Engage the water pump and establish a 125 psi (862 kPa) pump pressure, but do not charge the hoseline with water.
(7) Maintain the water temperature in the pump by circulating pump water through the water tank.
(8) Ensure that air pressure and water pressure are within ±10 percent.
(9) Fill the hoseline with compressed air.
(10) Slowly (no faster than in 3 seconds, and no slower than in 10 seconds) open the nozzle until it is no more than one-quarter open.
(11) Check to ensure that the air pressure and water pressure are within ±10 percent of the original set point.
(12) Close the nozzle.
(13) Continue to operate the air and water system for 5 minutes.
(14) Check to see that the water pressure and air pressure remain within ±10 percent of the original set point.

24.4.3 If the CAFS does not maintain the water pressure and air pressure within ±10 percent of the original set point, or if the air compressor temperature exceeds the manufacturer's limit during the test, the test shall be stopped and the test shall be considered a failure.

Chapter 25 Performance Testing of Line Voltage Electrical Systems

25.1 General. If the fire emergency vehicle is equipped with a line voltage electrical system, the system and components shall be tested as required by this chapter.

25.2* Frequency. Performance tests shall be conducted at least annually, unless otherwise noted, and whenever major repairs or modifications to the line voltage electrical system or any component of the system have been made.

25.3 Power Source Testing.

25.3.1 The line voltage power source shall be tested annually except when the full load test in Section 25.7 is performed.

25.3.2 The power source shall be tested at between 50 percent and 100 percent of the limit specified in 25.3.3.

25.3.2.1 The test shall be performed using the electrical loads typically carried on the emergency vehicle, with additional loads if necessary.

25.3.2.2 The test shall be performed using a load bank.

25.3.3 The total electrical load applied shall not exceed the continuous rating as specified on the power source specification label, or the power source nameplate rating if there is no power source specification label.

25.3.4 The power source shall be run for a minimum of 10 minutes under the test load specified in 25.3.2.

25.3.5 The voltage, frequency, and load shall be measured and recorded at the following times:

(1) At the beginning of the test under no load conditions
(2) After the test load has been applied
(3) After 10 minutes under test load
(4) At the end of the test when the test load has been removed

25.3.5.1 If the power source has a minimum turn-on load threshold, the conditions specified in 25.3.5(1) and 25.3.5(4) shall include sufficient load to exceed the minimum turn-on load threshold.

25.3.6 The voltage shall be within ±10 percent of the rated voltage at all points throughout the test.

25.3.7 The frequency shall be within ±3 Hz of the rated frequency at all points throughout the test.

25.4 Receptacle Wiring.

25.4.1* The polarity of the wiring, the ground continuity, and the neutral bonding or isolation of all 120-volt outlets shall be tested, including receptacles on the body, cord reels, and aerial device.

25.4.1.1* If the neutral conductor is bonded to the vehicle frame, the testing shall be done with a tester that verifies that the hot and neutral wires are connected to the correct receptacle pins and that the ground is connected.

25.4.1.2* If the neutral is not bonded to the vehicle frame, the testing shall be done with the power off using a continuity tester or ohmmeter to verify that both of the current-carrying conductors are isolated from the vehicle body and frame, and that the protective ground is connected to the vehicle body and frame

25.4.2* Any receptacle that can be powered both from an onboard power source and from a shore line shall be tested both ways.

25.4.3 Duplex receptacles shall be tested in each receptacle.

25.5* GFCI Testing. If the wiring system or any appliances on the emergency vehicle incorporate ground fault circuit interrupters (GFCIs), they shall be operationally checked in accordance with this section.

25.5.1 All GFCIs shall be checked, whether they are integrated into receptacles or circuit breakers or they are separate devices.

25.5.2 The operational check shall verify the following:

(1) That the integrated test button trips the GFCI
(2) That the reset button restores the GFCI
(3)* That the GFCI trips when a ground fault is simulated with an external tester

25.6* Line Voltage Equipment Testing.

25.6.1* All line voltage equipment on the emergency vehicle shall be run for a minimum of 10 minutes.

25.6.2 The testing shall include, but not be limited to, the following components:

(1) Light towers
(2) Permanently wired lights
(3) Electric motors
(4) Fixed wired appliances

(5) Receptacles (each individual receptacle if in multiples), fixed cords, and cord reels each loaded to at least 50 percent of the rating of the circuit breaker for that circuit

25.6.3* All equipment shall operate properly without arcing, failure, or excessive heating.

25.7 Full Load Test of Power Source.

25.7.1 The full load test of the power source shall be performed at least every 5 years.

25.7.2* The test load shall be at least 95 percent of the power source specification label rating, if present, or otherwise shall be at least 80 percent of the nameplate rating label.

25.7.3 If the emergency vehicle is equipped with a fire pump, during the power source test, the fire pump shall be running at the pressures and flows specified in 21.7.7.

25.7.4 Test Procedure.

25.7.4.1 The power source shall be started with no load, and the voltage and frequency shall be measured and recorded.

25.7.4.1.1 If the power source has a minimum turn-on load threshold, sufficient load shall be applied to exceed the minimum turn-on threshold for this step.

25.7.4.2 The power source shall be loaded to 50 percent ±10 percent of the load specified in 25.7.2, and the voltage and frequency shall be measured and recorded.

25.7.4.3 The power source shall be loaded to the load specified in 25.7.2, and the voltage and frequency shall be measured and recorded.

25.7.4.4 The power source shall be operated for 40 minutes, and the voltage and frequency shall be measured and recorded at the start of operation and every 10 minutes thereafter.

25.7.4.5 The power source shall be unloaded to 50 percent ±10 percent of the load specified in 25.7.2, and the voltage and frequency shall be measured and recorded.

25.7.4.6 The power source shall be completely unloaded, and the voltage and frequency shall be measured and recorded.

25.7.4.6.1 If the power source has a minimum turn-on load threshold, sufficient load shall be applied to exceed the minimum turn-on load threshold for this step.

25.7.4.7 The voltage shall be within ±10 percent of the rated voltage at all points throughout the test.

25.7.4.8 The frequency shall be within ±3 Hz of the rated frequency at all points throughout the test.

Chapter 26 Performance Testing of Breathing Air Compressor Systems

26.1 General.

26.1.1 If the emergency vehicle is supplied with a breathing air compressor system, the compressor system shall be tested annually by the manufacturer or the manufacturer's authorized representative to verify that the system still meets the manufacturer's requirements for the system when it was new.

26.1.2 If the manufacturer of the breathing air compressor system is no longer in business and therefore is not available to test the system, the system shall be tested using accepted industry practices by a service company that has experience with high-pressure breathing air systems.

26.2 Air Quality.

26.2.1 The quality of air produced by the breathing air compressor system shall be tested in accordance with NFPA 1989 following completion of the annual test.

26.2.2 If the annual test of the breathing air compressor system is conducted at the same time that the system is serviced as required by 15.1.1, a single test of the air quality shall be permitted following both the servicing and testing.

26.3 Records. Records shall be maintained of all annual testing of the breathing air compressor system.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.5 Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). The liter, a unit that is outside of but recognized by SI, is commonly used in international fire protection. Table A.1.5(a), Table A.1.5(b), and Table A.1.5(c) provide conversion factors as an aid to the user. Table A.1.5(d) provides a list of the abbreviations used in this standard and their meaning.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such

Table A.1.5(a) Conversion Factors: U.S. Units to SI Units

U.S. Units		SI Units
1 gallon per minute (gpm)	=	3.785 liters per minute (L/min)
1 imperial gallon per minute (igpm)	=	4.546 liters per minute (L/min)
1 pound per square inch (psi)	=	6.895 kilopascals (kPa)
1 inch of mercury (in. Hg) at 60°F (15.6°C)	=	3.376 kilopascals (kPa)
1 inch (in.)	=	25.40 millimeters (mm)
1 foot (ft)	=	0.3048 meter (m)
1 cubic foot (ft^3)	=	0.02832 cubic meter (m^3)
1 square inch ($in.^2$)	=	645.2 square millimeters (mm^2)
1 mile per hour (mph)	=	1.609 kilometer per hour (km/hr)
1 pound (lb)	=	0.4536 kilogram (kg)

standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

Table A.1.5(b) Conversion Factors: SI Units to U.S. Units

S.I. Units		U.S. Units
1 liter per minute (L/min)	=	0.2642 gallon per minute (gpm)
1 liter per minute (L/min)	=	0.2200 imperial gallon per minute (igpm)
1 kilopascal (kPa)	=	0.1450 pound per square inch (psi)
1 kilopascal (kPa)	=	0.2962 inch of mercury (in. Hg) at 60°F (15.6°C)
1 millimeter (mm)	=	0.03937 inch (in.)
1 meter (m)	=	3.281 feet (ft)
1 cubic meter (m^3)	=	35.31 cubic feet (ft^3)
1 kilometer per hour (km/hr)	=	0.6214 mile per hour (mph)
1 kilogram (kg)	=	2.205 pounds (lb)
1 lux (lx)	=	0.09290 footcandle (fc)

Table A.1.5(c) Useful Conversion Factors

1 gallon per minute (gpm)	=	0.833 imperial gallon per minute (igpm)
1 imperial gallon per minute (igpm)	=	1.2 gallons per minute (gpm)
1 foot (ft) of water	=	0.433 pound per square inch (psi)
1 pound per square inch (psi)	=	2.31 feet (ft) of water
1 metric ton (mton)	=	1000 kilograms (kg)
1 kilopascal (kPa)	=	0.01 bar
1 bar	=	100 kilopascals (kPa)

Table A.1.5(d) Abbreviations Used in This Standard

Abbreviation	Term
ac	alternating current
AHJ	authority having jurisdiction
C	centigrade
CAFS	compressed air–foam system
CCA	cold cranking amperage
dc	direct current
F	Fahrenheit
ft	feet
gpm	gallons per minute
in.	inch
in. Hg	inches of mercury
kg	kilogram
km/hr	kilometers per hour
kPa	kilopascal
L	liter
L/min	liters per minute
lb	pound
m	meter
mm	millimeter
mph	miles per hour
psi	pounds per square inch
V	volts

A.3.3.14 Auxiliary Pump. An auxiliary pump can be a pump that is secondary to a fire pump to achieve pump and roll capability or to provide high-pressure hose reel operations. It could also be the only pump on a special service or wildland fire apparatus for which the desired performance is different than that of a fire pump, an industrial supply pump, or a transfer pump.

A.3.3.28 Compound Gauge. On most gauges, zero equals atmospheric pressure. Gauges typically measure pressure above atmospheric pressure in pounds per square inch (psi) [kilopascals (kPa)] and below atmospheric pressure in inches of mercury (in. Hg) [kilopascals (kPa)].

A.3.3.41 Electronic Battery Conductance Tester. A conductivity tester displays a battery's cold cranking amps (CCA) value based on the amount of battery plate surface area available upon which electrochemical activity can occur.

A.3.3.47 Emergency Vehicle. Title 49, CFR 301 defines a motor vehicle, in part, as a vehicle driven or drawn by mechanical power and manufactured primarily for use on public streets, roads, and highways. Nothing in this standard prevents the AHJ from applying these requirements to any vehicle with a GVWR of less than 5001 lb (2268 kg).

A.3.3.66 Instability. The lifting of a tire or stabilizer on the opposite side of the vehicle from the load does not necessarily indicate a condition of instability. Instability occurs when an aerial device can no longer support a given load and overturning is imminent.

A.3.3.84 Net Pump Pressure. When operating from a hydrant, the net pump pressure typically is less than the discharge pressure. For example, if the discharge pressure gauge reads 150 psi (1034 kPa) and the intake (suction) gauge reads 20 psi (138 kPa), the net pump pressure equals 130 psi (896 kPa). When operating from draft, the net pump pressure will be above the discharge pressure. For example, if the discharge pressure gauge reads 145 psi (1000 kPa) and the intake (suction) gauge reads 10 in. Hg (34 kPa) vacuum, the net pump pressure will be 150 psi (1034 kPa) (1 in. Hg = 0.5 psi = 3.4 kPa).

A.3.3.90 Optical Source. An optical source can consist of a single optical element or a fixed array of any number of optical elements where their geometric positioning relative to each other is fixed by the manufacturer of the optical source and cannot be easily modified. [**1901,** 2016]

A.3.3.105 Rated Vertical Height. For an aerial ladder, rated vertical height is measured from the outermost rung of the outermost fly section, with the ladder at maximum elevation and extension. For an elevating platform, rated vertical height is measured from the top of the platform handrails with the platform raised to its position of maximum elevation and extension, and for a water tower, rated vertical height is measured from the discharge end of the nozzle with the boom raised to its position of maximum elevation and extension.

A.3.3.134 Vacuum. Typically, vacuum is expressed in inches of mercury (in. Hg) [kilopascals (kPa)].

A.4.1 The intent is to include reserve emergency vehicle that are fully equipped as well as reserve emergency vehicle that might need to be equipped with hose, tools, and equipment before being ready to respond.

A.4.3.1.1 Additional qualifications can be identified by schooling, training, experience, and recognized certification programs, such as those administered by Automotive Service Excellence (ASE), Emergency Vehicle Technician Certification Commission, Inc., or other equivalent certifying agencies.

A 4.3.2 Persons performing daily/weekly inspec ions and operational checks of emergency vehicles should be qualified to be drivers/operators for the type of vehicle being checked.

A.4.4.1 Emergency vehicles are complex machines that involve all kinds of mechanical, electrical, and chemical hazards. Failure to consult the appropriate manuals might result in serious injury to the person performing the inspection or maintenance or to other persons in the area.

A.4.4.3 One area in which there are regulations in the United States is the area of tire and wheel service, which is covered under the Occupational Safety and Health Administration (OSHA) regulations specified in 29 CFR 1910.177.

A.4.5.2 If the emergency vehicle manufacturer is no longer in business, or the servicing and maintenance criteria or recommendations are no longer available from the manufacturer, the fire department should establish the criteria that are necessary to inspect and maintain the specific emergency vehicle. These criteria can be established by discussing inspection and maintenance procedures for similar types or styles of emergency vehicles or components with persons experienced with such maintenance and by reviewing the industry standards that were in effect at the time the emergency vehicle or component was built. The criteria should be developed in writing.

The *Passenger Vehicles & Light Trucks Vehicle Inspection Handbook* and the *Trucks, Buses, & Trailers Vehicle Inspection Handbook*, prepared by the American Association of Motor Vehicle Administrators, provide a valuable resource in developing an inspection program.

A.4.5.3 The frequency of use (for example, hours, miles, and time) of emergency vehicles (duty cycle) might require that diagnostic checking, inspection, and maintenance be completed on a monthly, quarterly, or semiannual basis.

A.4.5.5 During an inspection, the technician should conduct a diagnostic check of the entire emergency vehicle to detect abnormal vibrations that could indicate a component defect or possible failure.

A.4.7 The AHJ should identify the state, provincial, and local regulations that pertain to record retention and follow them as a minimum.

A.5.1 Unsafe emergency vehicles pose severe safety risks to emergency responders and the general public. These risks result in death, severe injury, and property loss. These risks are particularly prevalent in older emergency vehicles. See Annex D for safety criteria on older emergency vehicles.

A.6.1.6 When a component on the emergency vehicle is taken out of service, a determination needs to be made as to whether the emergency vehicle is suitable for continued use. If any component that affects the operation of the chassis, the other components used during response, or the operational safety of the emergency vehicle is taken out of service, the entire emergency vehicle should be taken out of service.

A.6.2.3 Deficiencies or problems might or might not make the emergency vehicle unsafe but will render it unusable for some operations. The AHJ should provide a list of limitations to be imposed or a list of enforced conditions under which the emergency vehicle *cannot* continue to be used, pending repair of the deficiency. That list should include, but is not limited to, the following:

( ) Compartment doors will not stay closed
(2) Running boards are not secure.
(3) Tailboard is not secure.
(4) Accessory step (folding step) is broken or missing.

Although this standard identifies that cracked or broken windshields and mirrors should be consideration for taking the emergency vehicle out of service, consideration should also be given to state, provincial, or local regulations. The AHJ should identify and follow the pertinent state, provincial, and local regulations.

A.6.3.1(4) Tread depth should be checked with a tread depth gauge. When inserted into the tire tread, the amount of tread left is indicated in $\frac{1}{32}$ in. (0.8 mm).

A.6.4.1 Loss of power can be the result of numerous items related to the engine, fuel system, and air intake system. Loss of power can be associated with loud or unusual noises. Loud or unusual noises can be the result of worn, damaged, or defective internal engine components, such as main and connecting rod bearings, connecting rods, piston pins, pistons, valve trains, and fuel systems. Loss of power can be the result of something as simple as clogged fuel or air filters. Inspection of the air intake restriction gauge will allow determination of the condition of the air intake system.

Many vehicles, especially those with water-fuel separators, have both audible and visual indicators to show failure of fuel system filters or the presence of excessive water. Another indicator of factors resulting in loss of power is engine exhaust smoke. As a rule, white smoke indicates a cooling system leak into the combustion area; blue smoke indicates excessive oil consumption, normally engine oil but in some applications transmission fluid; and black smoke indicates excessive unburned fuel. In any case, any one of the aforementioned items can deter from proper and safe operation of the vehicle and should therefore be remedied as soon as possible.

See also A.8.4.5 and A.8.6.

A.6.7.1(4) Burned-out lamps and other deficiencies should be corrected immediately. While all systems have a degree of redundancy, they are not designed to operate with multiple deficiencies. When more than one optical source in the warning light system is inoperative and the emergency vehicle must be used, it should be driven as a nonemergency vehicle.

A.6.7.3(1) When the audible warning system is inoperative and the emergency vehicle must be used, it should be driven as a nonemergency vehicle.

A.6.8.1.1 Paragraph 6.8.1.1(1) refers to the leak-down rate of the supply side of the air system. Paragraph 6.8.1.1(2) refers to the leak-down rate of the applied side of the air system. Paragraph 6.8.1.1(8) refers to the air compressor's ability to supply ample air for correct and safe operation of the vehicle.

Although this standard identifies out-of-service criteria for air brake systems, consideration should also be given to state or local regulations. The authority having jurisdiction should identify and follow the pertinent state and local regulations to ensure the vehicle is safe to operate.

Lining thickness of less than $\frac{3}{16}$ in. (4.8 mm) for a brake shoe with a continuous strip of lining, $\frac{1}{4}$ in. (6.4 mm) to the wear indicator for a shoe with two pads for drum brakes, or less than $\frac{1}{8}$ in. (3.2 mm) of lining for disc pads should be considered worn out, and the lining should be replaced.

A.6.8.2 1 Although this standard identifies out-of-service criteria for hydraulic brake systems, consideration should also be given to state or local regulations. The AHJ should identify and follow the pertinent state and local regulations to ensure the vehicle is safe to operate.

Lining thickness of less than $\frac{1}{16}$ in. (1.6 mm) for a brake shoe or disk should be considered worn out and should be replaced.

A.6.9.1(6) Beginning with the 1991 edition of NFPA 1901, fire apparatus equipped with electronic or electric engine throttle controls are required to include an interlock system to prevent engine speed advancement, unless the chassis transmission is in neutral with the parking brake engaged; or unless the parking brake is engaged, the fire pump is engaged, and the chassis transmission is in pumping gear; or unless the apparatus is in the "okay to pump" mode.

A.6.11.1(7) Tread depth should be checked with a tread depth gauge. When inserted into the tire tread, the amount of tread left is indicated in $\frac{1}{32}$ in. (0.8 mm) increments.

A.7.1 The importance of the daily / weekly checks cannot be stressed enough. For a preventive maintenance plan to succeed the daily/weekly visual and operational checks must be done correctly. Properly done daily/weekly checks quickly locate problems that can be corrected before they become worse. The AHJ should work with the maintenance department to develop a plan to complete the daily/weekly checks within the allotted time, complete the checks thoroughly, and document the results properly. The driver/ operators assigned to perform the daily/weekly checks should be trained with the help of the maintenance department and technicians regarding the expected outcome of each item on the check sheet. Other groups, such as state mechanics associations, apparatus manufacturers, and independent trainers offer some training for driver operators. NFPA 1002 has requirements for what a driver operator should know to perform the daily/weekly checks.

A.8.3.3 It is important that the cold tire inflation be maintained to the emergency vehicle manufacturer's recommended tire pressure, which is based on the weight of the completed vehicle, and not to the maximum pressure shown on the sidewall of the tire. If the information from the emergency vehicle manufacturer is not available for the tires on the vehicle, each axle should be weighed with the vehicle fully loaded and the tires inflated to the tire manufacturer's inflation specification for the tire model, size, and axle load.

A.8.3.4 Some apparatus may use tires based on an intermittent duty (fire service) load rating. This information is available from the tire manufacturer or the apparatus manufacturer. Fire service ratings are based on the assumption that the truck will never drive with this load for more than 50 miles (80 km) (1 hour for some manufacturers) without stopping to cool the tires. The AHJ must understand this limitation.

A.8.3.6 Tire age can be determined by checking the DOT code on the sidewall of each tire. The code begins with "DOT" and ends with a 3-digit (through 1999) or 4-digit (2000 and beyond) date code. The first 2 digits of the date code are the week of the year the tire was manufactured, and the last 1 or 2 digits indicate the year. For example, "DOT GJ HU234 319" was manufactured in week 31 of 1999. "DOT BT FR87 2501" was manufactured in week 25 of 2001. The code may be on the inside or outside sidewall

A.8.3.7 Wheel attaching hardware should be torqued to the manufacturer's recommendation at the time of wheel installation. The wheel- or rim-attaching hardware should be retorqued at 50 mi to 100 mi (80 km to 160 km) after installation and periodically thereafter. Wheel covers or nut covers might have to be removed for proper inspection.

A.8.4.5 To ensure efficient engine performance and extended valve and injector service life, a scheduled valve lash and injector height measurement and adjustment schedule should be maintained. Certain engines might also require nozzle and pump calibration, timing, replacement of spark plugs, ignition system tests, or other adjustments.

It is imperative that all engine components and accessories that can affect engine performance be inspected, adjusted, and maintained. Visual inspections along with air restriction tests performed on a regularly scheduled basis will ensure proper operation of components. Examples of engine performance concerns are abnormal black, blue, or white exhaust smoke and abnormal engine noises.

Other pertinent tests might be required for the engine to perform at maximum efficiency on an emergency scene. All recommended tests and adjustments should be performed to ensure proper operation.

Failure to perform factory-recommended engine adjustments or inspections that are required initially and at regular intervals thereafter, or failure to make necessary adjustments or part replacements (for example, spark plugs on gas engines), might result in gradual degradation of engine performance and reduced fuel combustion efficiency.

Increasing the engine performance through any means, such as reprogramming, might cause the engine to produce more power, torque, or both than other components on the chassis are rated to handle. This situation can have serious safety implications.

A.8.6 Fuel systems are essential components of the engine. To ensure that the engine is capable of proper performance and operation, the fuel system should be inspected and tested to the manufacturer's specifications. Quality fuel must be utilized. The fuel filters (primary and secondary, if equipped) should be replaced or serviced on a regular basis, normally at 6-month intervals or at every oil change is recommended. Fuel pressure should be tested utilizing factory-recommended procedures. Fuel spill-back (return) should also be included in fuel system checks. Some manufacturers recommend that a fuel suction test be performed to test the suction capabilities of the fuel pump and suction side of the fuel system.

A.8.6.5 All linkage should be inspected for freedom of movement, adjustment, full throttle position, idle position, and smooth operation.

A.8.12.1 Severe duty (conditions) scheduling applies to brake system maintenance due to the normal hard braking encountered with the emergency vehicle.

A brake maintenance schedule for each emergency vehicle should be set after the brakes have been inspected several times. This schedule should include both minor inspections and major inspections as follows:

(1) For minor inspections, the brakes, brake linings or pads, and slack adjusters should be inspected for freedom of movement, security of mounting, and deformation and should be tested for proper operation.
(2) The slack adjuster should be lubricated according to a schedule that provides the most frequent inspection and lubrication based on one of the following:
    (a) Schedule for chassis lubrication used by the department
    (b) Schedule for chassis lubrication recommended by the manufacturer of the chassis
    (c) At least four times during the life of the linings
(3) Major inspections should be performed whenever the brakes are relined, or at least once a year, whichever comes first, and should include the following:
    (a) All procedures, inspections, and measurements recommended by the manufacturer for relining the brakes
    (b) Lubrication of the slack adjuster and caliper, if equipped
    (c) Adjustment of the brakes as described in the manufacturer's literature

A.8.14.6 For the safety of personnel riding in the driving or crew area, the equipment specified in 8.14.6 should be mounted in accordance with the requirements of NFPA 1901.

A.8.14.7.1 If the cab has a powered tilting system that does not have an interlock system, consideration should be given to providing an interlock to allow operation only when the parking brake is engaged.

A.8.15.4 If the emergency vehicle does not have the reflective striping, consideration should be given to adding the striping in accordance with applicable sections of the current editions of NFPA 1901, NFPA 1906, NFPA 1917, or other applicable documents.

A.8.15.5 If the emergency vehicle does not have the warning labels, consideration should be given to adding the warning labels in accordance with applicable sections of the current editions of NFPA 1901, NFPA 1906, NFPA 1917, or other applicable documents.

A.9.5.2 Alternators are required to be performance tested at least annually and after certain repairs *(see Section 20.5)*. The purpose of the diagnostic check specified in Chapter 9 is not to duplicate the tests required in the annual performance test but to ensure the component is working properly. If the alternator is working, the voltage should increase after starting the engine, and the ammeter (if equipped) should read positive.

A.10.2.1 Fire pumps and industrial supply pumps are required to be performance tested at least annually and after certain repairs *(see Chapter 21)*. The purpose of the diagnostic check specified in Chapter 10 is not to duplicate the tests required in the annual performance test but to ensure that the component is working properly.

A.10.2.4.1 Components of the pump drive system could include, but are not limited to, the following:

(1) Split-shaft power takeoff (PTO)
(2) Pump transmission
(3) Pump transfer case
(4) PTO
(5) Pump clutch
(6) Pump drive shafts
(7) Hydraulic drive systems
(8) Auxiliary drive engine

A.10.2.4.2 Pump shift controls can include electrical, pneumatic, or mechanical components working individually or in combination to shift the pump drive system into and out of pump mode. Some pumps have manual backup shift controls. Pump shift indicators in-cab and on the operator's panel on split-shaft PTO pump drive systems typically require an electromechanical device, such as a switch mounted on the pump transmission, to sense pump shift status. The controls need to be inspected, diagnostically checked, and lubricated as part of a preventive maintenance program.

Beginning with the 1991 edition of NFPA 1901, fire apparatus equipped with electronic or electric engine throttle controls are required to include an interlock system to prevent engine speed advancement, unless the chassis transmission is in neutral with the parking brake engaged; or unless the parking brake is engaged, the fire pump is engaged, and the chassis transmission is in pumping gear; or unless the apparatus is in the "okay to pump" mode.

A.12.1 It is important for the operator, maintenance personnel, and fire apparatus technician to understand the types and properties of mechanical foam and its application to maintain a foam proportioner system. Specific information regarding foam concentrates, their corrosive characteristics, their biodegradability, and their application is available in NFPA 11. Information on foam concentrates for Class A fires is available in NFPA 1150. A thorough knowledge of foam and foam systems will enhance the ability to maintain systems in peak operating conditions at all times.

There are many designs for foam proportioning systems. These systems include, but are not limited to, the following:

(1) Eductor systems
(2) Self-educting master stream nozzles
(3) Intake-side foam proportioning systems
(4) Around-the-pump foam proportioning systems
(5) Balanced pressure foam proportioning systems
(6) Direct injection foam proportioning systems

Annex A of NFPA 1901 describes these systems and variations thereof. A review of that material will assist with the understanding of foam proportioning systems.

A.12.3 Most foam system manufacturers differentiate between the materials they recommend for foam proportioning system components that are designed to be flushed with water after operation and those components that are intended to be wetted continuously with foam concentrate (that is, some positive displacement pumps are designed to be completely full of foam concentrate).

A.13.3.3.1 Special attention should be paid to the cleanliness and security of engine covers, cooling fins, and fans on air-cooled engines, as they are critical to the proper operation of the engine.

A.14.7.1.1 It is important to check the cleanliness and security of engine covers, cooling fins, and fans on air-cooled engines, as these factors are critical to the proper operation of the engine.

A.15.8 There are refill stations currently on emergency vehicles that were never designed to the current requirements of NFPA 1901 and whose design has never been certified by an independent third-party certification organization. These include open-top fragmentation tubes and closed systems that have never been tested to determine if they will contain all fragments of a failed cylinder so as to protect the operator. If a commercial refill station is on the emergency vehicle, it might be possible to confirm with the manufacturer whether the design of the unit meets current standards. Older refill stations should be considered for replacement with refill stations that meet the current NFPA 1901 standard.

A.15.9.1.1 Special attention should be paid to the cleanliness and security of engine covers, cooling fins, and fans on air-cooled engines, as they are critical to the proper operation of the engine.

A.16.2.8 It is important that the cold tire inflation be maintained to the fire apparatus manufacturer's recommended tire pressure, which is based on the weight of the completed apparatus, and not to the maximum pressure shown on the sidewall of the tire. If the information from the fire apparatus manufacturer is not available for the tires on the vehicle, each axle should be weighed with the vehicle fully loaded and the tires inflated to the tire manufacturer's inflation specification for the tire model, size, and axle load.

A.16.2.9 Tire age can be determined by checking the DOT code on the sidewall of each tire. The code begins with DOT and ends with a 3-digit (through 1999) or 4-digit (2000 and beyond) date code. The first two digits of the date code indicate the week of the year the tire was manufactured, and the last one or two digits indicate the year. For example, DOT GJ HU234 319 was manufactured in week 31 of 1999. DOT BT FR87 2501 was manufactured in week 25 of 2001. The code may be on the inside or outside sidewall.

A.19.2.3 If the scales allow, the right side and the left side of the emergency vehicle should also be weighed. The side-to-side tire load variation should be no more than 7 percent of the total tire load for a given tire's axle.

A.19.2.4(3) In some chassis designs, the personnel weight is centered over the front axle and the entire personnel weight can be entered in the front axle column. If not, the weight allocation for each seating position can be calculated as follows:

[A.19.2.4(3)a]

$$\text{front weight} = \frac{200\ \text{lb}\ (90\ \text{kg}) \times \begin{pmatrix}\text{wheel base} - \text{distance aft} \\ \text{of front axle to seat}\end{pmatrix}}{\text{wheel base}}$$

If the seat is forward of the front axle, the distance is negative or the value should be added to the wheel base in the numerator formula (wheel base + seat distance forward of front axle).

The weight on the rear axle attributed to each seating position equals 200 lb (90 kg) minus the weight attributed to that seating position on the front axle.

[A.19.2.4(3)b]

$$\text{rear weight} = 200\ \text{lb}\ (90\ \text{kg}) - \text{front weight}$$

If the seat is not between the front and rear axle, one of the weights will be negative

Figure A.19.2.4(3) is an example that shows four potential seating areas along the length of an emergency vehicle with a 240 in. wheelbase. Each seating area could have more than one seating position (e.g., the driver's seat and officer's seat at the front of the vehicle).

Table A.19.2.4(3) shows the net effect of a seating position on the axle loadings at each of the four seating locations along the vehicle as shown in Figure A.19.2.4(3).

A.19.2.4(4) The reference to "additional equipment" is intended to account for equipment added to an emergency vehicle for specific calls. This equipment could include, but is not limited to, ice rescue sleds, water rescue crafts, wildland fire fighter supplies, hose bridges, and portable water tanks added to the vehicle for particular responses. The purpose of such additions is to honestly assess the fully loaded weight of an emergency vehicle responding to any emergency or any service offered by the department. For this reason, where the equipment added to the apparatus is as important as standard equipment, the added equipment's weight should be recorded on line D of Figure 19.2.4 to represent where the additional weight impacts the apparatus.

If the emergency vehicle is to be used for extended operations away from the community where it is normally housed, such that the emergency responders will be taking personal clothing and equipment with them, an additional allowance of 70 lb (32 kg) per seating position should be included.

Table A.19.2.4(3) Effect of Seat Location on Axle Loading

Seating Location on Figure	Distance from Front Axle (in.)	Wheelbase (in.)	Weight on Front Axle (lb)	Weight on Rear Axle (lb)	Total Value (lb)
A	–24	240	220*	–20*	200
B	48	240	160*	40*	200
C	150	240	75*	125*	200
D	300	240	–50*	250*	200

*Final weight entered on Figure 19.2.4 needs to reflect this weight times the number of seating positions at this location.

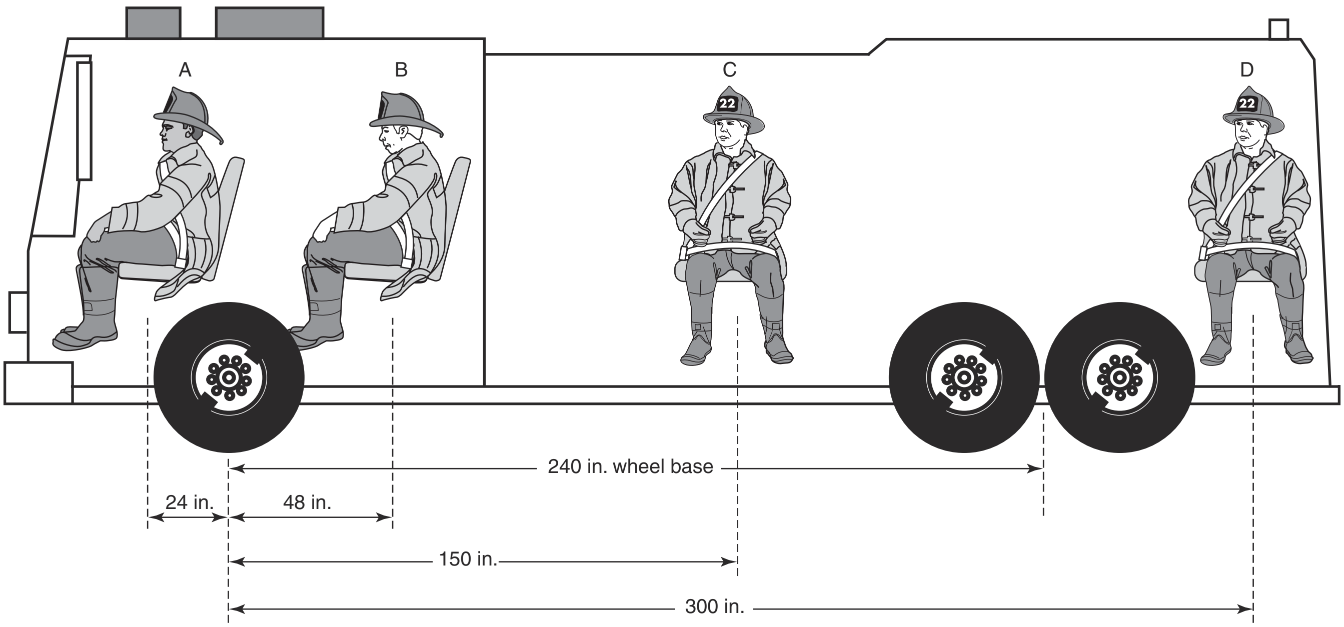

FIGURE A.19.2.4(3) Diagram of an Emergency Vehicle Showing Potential Seating Locations.

A.19.3.3 Figure A.19.3.3 shows the layout of the brake test area.

A.19.4.1 The parking brake should be tested to the chassis manufacturer's recommendations. NFPA 1901 has required a parking brake system to hold a fully loaded emergency vehicle on at least a 20 percent grade since 1991. If the emergency vehicle parking brake system was not designed to perform up to these or applicable federal standards, or if the AHJ operates the emergency vehicle beyond these standards, the AHJ should develop a standard operating guideline to supplement the emergency vehicle parking brake system.

A.19.4.2 If grades of over 20 percent are present in the normal response area of the emergency vehicle, the emergency vehicle parking brake system should be tested on the steeper grade. If the vehicle fails to hold, the AHJ should develop a standard operating guideline to supplement the emergency vehicle parking brake system.

A.20.2 "Major repairs" does not necessarily refer to the length of time that a repair takes but rather whether or not a repair potentially affects the operation or safety of any aspect of the low-voltage electrical system. This might include repairs unrelated to the low-voltage electrical system, such as body repairs, that might disturb wiring or other parts of the system. Testing should be performed to verify that, after the repair, the system is operating properly and safely.

A.20.3.2.1 Conductivity testing is preferred to load testing because it does not stress the battery, it is a more accurate indication of the state of health of the battery, and it provides values that can be recorded and tracked for trend analysis.

A.20.4 This test verifies that the wiring to the starter is in good condition and the connections are tight and free of internal corrosion.

A.20.5 This test verifies the output of the alternator and the alternator wiring.

A.20.5.5 If any portion of this test fails, it might indicate a problem with the alternator, or the problem might be with some other component of the electrical system. If the test fails, a qualified technician should do further investigation to determine the exact problem.

A.20.5.5(7) If the system includes a battery isolator, the voltage drop is the sum of the drop between the alternator and the battery isolator and the drop between the battery isolator and the battery.

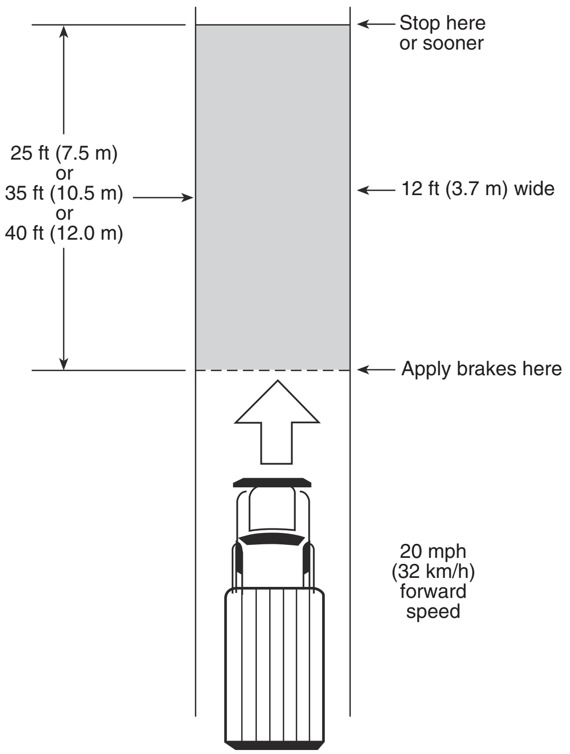

FIGURE A.19.3.3 Layout of a Brake Test Area.

A.20.6.6 If any portion of this test fails, it might indicate a problem with the regulator, or the problem might be with some other component of the electrical system If the test fails, a qualified technician should do further investigation to determine the exact problem.

A.20.8 This test is designed to verify that the charging system, with the load management system, if supplied, is sufficient to supply the total connected load.

A.20.8.3(2) The total continuous electrical load includes all continuous electrical equipment on the apparatus, including heating and air-conditioning, warning and scene lights, marker and head lights, step and ground lights, compartment lights, and other low-voltage equipment. It excludes intermittent loads, such as starter, primer, reel rewind motors, sirens, and horns.

A.20.8.4 The alternator is supposed to be able to supply the total continuous electrical load, as adjusted by the load management system. If the electrical system is working properly and is capable of sustaining the electrical load, no current should be drawn from the batteries during this test. The voltage at the battery terminals should remain constant if the batteries are fully charged or go up if the batteries are not fully charged. The allowance for a drop of 0.05 V allows for normal voltage variation and instrument errors.

A.20.9.3 An excessive voltage drop across a power relay or solenoid indicates a problem with the component and, if not repaired, will often lead to a failure of the device by which it is controlled.

A.21.1 Some fire apparatus is equipped with an auxiliary pump or a transfer pump. Any water pump used in fire-fighting operations not classified as a fire pump or industrial supply pump should be tested on an annual basis and the test results examined year-to-year for unexplained changes that could indicate developing problems with the pump or the engine driving the pump.

If there are no test results and no test procedure from previous testing of the pump, the procedure that follows is recommended on an annual basis.

Determine the pump shutoff pressure as follows:

(1) Engage the pump and, while taking suction from the water tank, close the discharge valve and advance the engine speed until the discharge pressure ceases to increase, taking care not to run the pump in this condition for more than 1 minute.
(2) Record the pump shutoff pressure.

Determine the discharge pressure and volume operating from the water tank on the apparatus as follows:

(1) Open the discharge valve and advance the engine speed until the pump is operating at the highest discharge rate possible for the normal pump discharge pressure, recognizing that the maximum discharge rate might be governed by the capacity of the pump or might be governed by the size and arrangement of the piping between the water tank and the pump.
(2) Measure the discharge rate using a flowmeter, a hoseline with a smoothbore nozzle of sufficient size, or another method.
(3) Continue to discharge water for 10 minutes or until the pressure begins to drop, whichever comes first, measuring the discharge rate and discharge pressure at 5-minute intervals.
(4) Average the discharge rates measured and the discharge pressure readings and record the results.

Determine the discharge pressure and volume operating from draft as follows:

(1) If the pump has other than an exhaust gas primer, cap the pump intake and close any discharge valves or cap any discharge outlets, operate the priming pump to develop at least 17 in. Hg (57.4 kPa) vacuum, and record the vacuum at the beginning and end of 5 minutes.
(2) Operate the pump at the maximum discharge rate that can be obtained at the normal pump discharge pressure when drafting using the suction hose carried on the fire apparatus for that pump at a lift of up to 10 ft (3 m).
(3) Measure the discharge rate using a flowmeter, a hoseline with a smoothbore nozzle of sufficient size, or another method.
(4) Continue to discharge water for 10 minutes, measuring the discharge rate and discharge pressure at 5-minute intervals.
(5) Average the discharge rates measured and the discharge pressure readings and record the results.
(6) Record the pump site conditions (suction hose size and length, lift, atmospheric pressure) and the pump test results, so the test can be repeated under similar conditions in future years.