"Hydraulic and Electric Brake Systems," and 49 CFR 571. 121, "Air Brake Systems." [**1901:** A.4.17.5]

A.4.18 Where the point of delivery is over 2000 ft (600 m) of elevation, it is important to test the pump and pumping engine performance to ensure that the engine can develop adequate power at the point of delivery. This test can be performed with the pump supplied from a fire hydrant or at draft, with the discharge and net pressure maintained at rating for the pump. The net pressure (P) when the pump is supplied from a hydrant with positive intake pressure is the discharge gauge pressure (D) minus the intake gauge pressure (S).

A.4.19 It is important for the purchaser and contractor to agree on the format in which the documentation is to be delivered. It is also important that the purchaser consider the long-term ramifications of changing media technology if electronic format is used for delivery of the documentation. Software and hardware will need to be maintained over the years to utilize electronic documentation. [**1901**:A.4.19]

A.4.20.2.3(6)(g) The equivalent circuit logic could be described in several ways. It might be shown as an equivalent schematic, a word-based description, or a table. In any case, it should define the relationship between input status and output status. [**1901**:A.4.20.2.3(6)(g)]

A.4.20.2.4 Suppliers of components and equipment installed or supplied by the contractor often supply operations and maintenance documents with those components or equipment. This standard requires that the contractor deliver these documents to the purchaser. The purchaser should specify if multiple copies of these documents are required. [**1901**:A.40.2.4]

A.4.21.3 The purchaser either accepts the vehicle as noncompliant or accepts responsibility that the apparatus will not be placed in emergency service until the apparatus has been modified as necessary to accomplish full compliance with this standard.

A.5.5 Additional compartmentation might be required to accommodate the size, shape, and weight of special equipment. Any special equipment to be carried on the apparatus should be identified in the specifications so the apparatus manufacturer can ensure the equipment will be properly accommodated within the design of the apparatus. [**1901**:A.5.5]

A.5.6 Hose storage areas are not required to be contiguous. The purchaser should consider arrangements for hose storage that will best support operational procedures. The purchaser should also consider specifying some type of cover for the hose compartment(s). Hinged or removable covers might be advantageous for wildland fire operations.

A.5.7.1(1) Parking brakes on FMVSS-certified apparatus are only designed to hold on a 20 percent grade. If departments intend to park on grades greater than 20 percent, they should consider specifying wheel chocks with higher performance. Chock performance criteria are not meant to encourage parking on a grade greater than 20 percent. The practice of parking on a grade greater than 20 percent should be performed by a two-person crew, with the driver staying in the cab with a foot on the service brake pedal and the second crew member setting or removing the chocks.

A.5.7.2 The equipment required by National Wildland Coordinating Group (NWCG) to be carried on wildland fire apparatus for national mobilization can be found in the *Interagency Standards for Fire and Fire Aviation Operations* or the National Interagency Fire Center website www.nifc.gov/policies/red_book.htm.

A.7.1 Mobile water supply fire apparatus are known as "tankers" in the eastern part of the United States and as "water tenders" in the western part of the United States.

In wildland fire fighting, two types of mobile water supply fire apparatus are used, "support" and "wildland." Wildland mobile water supply fire apparatus are used for fire suppression activities. Support mobile water supply fire apparatus are typically contractor-owned construction equipment and are not used for fire suppression.

This standard covers the wildland mobile water supply fire apparatus.

A.7.5 Additional compartmentation might be required to accommodate the size, shape, and weight of special equipment. Any special equipment to be carried on the apparatus should be identified in the specifications so that the apparatus manufacturer can ensure the equipment will be properly accommodated within the design of the apparatus. [**1901**:A.7.4]

A.7.6 Hose storage areas are not required to be contiguous. The purchaser should consider arrangements for hose storage that will best support operational procedures, particularly if hose is to be carried preconnected to the tank inlet or a pump discharge. The purchaser should also consider specifying some type of cover for the hose compartment(s). Hinged or removable covers might be advantageous for wildland fire operations. The purchaser should provide the apparatus manufacturer with details regarding the size and length of suction or supply hose and what arrangement for storage of the hose is desired so that the manufacturer can more accurately provide appropriate accommodations for the hose.

A.7.6.1 The purchaser should specify the location and the arrangement of the hose storage area to allow carrying of the hose preconnected to the tank inlet. The purchaser should also consider specifying some type of cover for the hose compartment. Hinged or removable covers might be desirable for wildland fire operations.

A.7.7.1(1) Parking brakes on FMVSS-certified apparatus are only designed to hold on a 20 percent grade. If departments intend to park on grades greater than 20 percent, they should consider specifying wheel chocks with higher performance. Chock performance criteria are not meant to encourage parking on a grade greater than 20 percent. The practice of parking on a gradegreater than 20 percent should only be performed by a two-person crew,with the driver staying in the cab with a foot on the service brake pedal and the second crew member setting or removing the chocks.

A.7.7.2 The equipment required by NWCG to be carried on wildland fire apparatus for national mobilization can be found in the *Interagency Standards for Fire and Fire Aviation Operations* or the National Interagency Fire Center website www.nifc.gov/policies/red_book.htm.

A.10.2.1(1) Parking brakes on FMVSS-certified apparatus, including those equipped with air brakes, are only designed to hold on a 20 percent grade. If departments intend to park on grades greater than 20 percent, they should consider specifying wheel chocks with higher performance. Chock performance criteria are not meant to encourage parking on a grade greater

than 20 percent. The practice of parking on a grade greater than 20 percent should be performed by a two-person crew, with the driver staying in the cab with a foot on the service brake pedal and the second crew member setting or removing the chocks.

A.10.3 Specification of vehicle air conditioning is a complex topic and cannot be accurately predicted by specifying a system with a particular Btu capacity. Btu capacity is often calculated for individual air-conditioning components, but will not reflect the actual output of the system nor guarantee a particular performance at the system level.

The performance of any vehicle air-conditioning system is dependent on many factors such as ambient temperature, humidity, solar load, duration of heat-soak, engine test rpm (i.e., refrigerant compressor speed), percent of fresh vs. recirculated air, and so on. The acceptability of a system has subjective criteria as well, such as the temperature and velocity of the vent air, whether the air can be directed at the occupant's face, and how quickly the system is able to attain the desired average temperature.

Purchasers who are particularly sensitive to air-conditioning performance might wish to consider specifying a system tested in accordance with SAE J2646, *Cab Air-Conditioning Test Procedure — Heavy Trucks with and without Sleepers*. Meeting a desired air-conditioning performance might require additional vehicle features, such as increased cab insulation or special window tinting.

A.10.7.1 If a seat belt–monitoring system is desired, it should be installed in accordance with the seat belt–monitoring requirements in NFPA 1901.

A.12.1 The carrying capacity of a vehicle is one of the least understood but one of the most important features of design. All vehicles are designed for a GVWR, which should not be exceeded by the purchaser after the vehicle has been placed in service.

Many factors make up the GVWR, including the design of the springs or suspension system, the rated axle capacity, the rated tire and wheel loading, and the distribution of the weight between the front and rear wheels.

Water Tank. One of the most critical factors is the size of the water tank. Water weighs approximately 8.3 lb/gal (1 kg/L). A value of 10 lb/gal (1.2 kg/L) can be used when estimating the weight of the tank and its water, making a 500 gal (2000 L) tank and its water about 5000 lb (2400 kg).

Miscellaneous Equipment. If the finished apparatus is not to be overloaded, the purchaser should provide the contractor with the weight of equipment to be carried if it is in excess of the allowance shown in Table 12.1.2.

Large Compartment Capacity. The manufacturer is required by the standard to provide a miscellaneous equipment allowance in compliance with the minimum allowance listed in Table 12.1.2. Purchasers who specify vehicles with large compartment capacity should work closely with the vehicle manufacturer to ensure that the GVWR is sufficient to carry the intended equipment. A vehicle with average compartment loading will have a miscellaneous equipment weight of about 8 lb/ft^3 (125 kg/m^3) of compartment space available for miscellaneous equipment. A very lightly loaded vehicle could have as little as 4 lb/ft^3 (65 kg/m^3). A heavily loaded vehicle can reach 12 lb/ft^3 (200 kg/m^3). This volume does not include space occupied by generators, reels, air systems, ladders, hose, and so forth, that are not in the miscellaneous equipment allowance. Total equipment weight varies significantly, depending on the density of the equipment and how tightly the fire department chooses to pack it.

Overloading. Overloading of the vehicle by the manufacturer through design or by the purchaser adding a great deal of equipment after the vehicle is in service will materially reduce the life of the vehicle and will undoubtedly result in increased maintenance costs, particularly with respect to the springs, tires, axles, transmissions, clutches, and brakes. Overloading can also seriously affect handling characteristics, making steering particularly difficult.

Underloading. Brake equipment on heavy vehicles can be sensitive to the weight distribution of the vehicle. Specifying a GVWR significantly greater than the estimated in-service weight can lead to poor brake performance, chatter, and squeal. Purchasers who specify configurations with limited compartment volume on a high-capacity chassis should consult the manufacturer to ensure that a vehicle with an underloaded condition will not result.

Purchaser Responsibility. The purchaser should specify the weight of the equipment to be carried if it is in excess of the allowance for miscellaneous equipment. This weight specification allows a chassis with an adequate GAWR and GVWR to be supplied. Specific additional equipment often necessary to meet the operational requirements of the department could include additional hose, chain saws, rations, tow chains, tire chains, drinking water containers, ice chests, additional hand tools, and additional containers of foam concentrate.

Severe Service. Fire apparatus have to be able to perform their intended service under adverse conditions. Wildland apparatus often are required to operate off paved roads. Chassis components should be selected with the rigors of service in mind.

Off-Road Use. If the apparatus is designed for off-road use, it is recommended that the apparatus, when loaded to its estimated in-service weight, should not exceed 80 percent of the chassis GVWR. In addition, the axle loads should not exceed 80 percent of the appropriate GAWR. If the vehicle chassis manufacturer certifies the GVWR and GAWR for 50 percent minimum off-road use, the full weight ratings can be utilized.

A.12.1.2(4) The 250 lb (114 kg) per person used here does not include the weight of SCBA and tools carried by a fire fighter, because the weight of this equipment is accounted for elsewhere. [**1901**:A.12.1.2(4)]

A.12.1.2(5) If the purchaser or dealer will be installing generators, reels, air systems, or other fixed equipment, the purchaser should notify the manufacturer, and allowance for this weight should be provided by the manufacturer in addition to the miscellaneous equipment allowance. **[1901**:A.12.1.2(5)]

A.12.1.2(7) The miscellaneous equipment allowances are minimum values based on the minimum compartment volume requirements. These values should be adequate for many volunteer departments responding to individual incidents that are suppressed in less than a 12-hour period. Those departments or agencies that send crews out for days or weeks at a time will likely need more carrying capacity both by weight and by volume. Apparatus that will be used in this manner should be specified accordingly. The ratio of 100 lb (45 kg) of weight

capacity for each 10 ft^3 (0.28 m^3) of compartment volume can be used as a conservative approach when configuring individual apparatus.

A.12.1.2(8) Wildland fire apparatus are not required to carry SCBA units. However, if the purchaser intends to carry SCBA units, accommodations need to be made for them and their weight included in the miscellaneous equipment allowance. The purchaser needs to work with the manufacturer on where the units will be carried, whether in seat backs or in compartments, and how they will be mounted.

A.12.1.4 A motor vehicle sold in the United States requires the affixing of a certification label or tag by the final-stage manufacturer of the motor vehicle stating that the vehicle meets all applicable Federal Motor Vehicle Safety Standards (49 CFR 571) and Federal Theft Prevention Standards (49 CFR 541). The location for affixing the certification label on the motor vehicle is a requirement of the federal standard requiring this label. See 49 CFR 567, "Certification," for more information. [**1901:**A.12.1.4]

A.12.1.5.1 It is important for fire apparatus drivers to understand the height, length, and weight of the vehicles compared to their personally owned vehicles. It is also important that this information be accurate. The height of the apparatus could change after delivery, depending on what equipment might be added; therefore, the fire department should note such changes on the label. Suggested wording for the label is shown in Figure A.12.1.5.1.

A.12.2.1.1 The maximum governed speed is established by the engine manufacturer as a safe limit of engine speed. The engine governor or electronic fuel control system should prevent the engine from exceeding the safe speed. Most engine manufacturers allow a plus tolerance of 2 percent for maximum governed speed. [**1901**:A.12.2.1.1]

A.12.2.1.3 A shutdown beyond the control of the pump operator during fire-fighting operations can result in loss of waterflow from the pump that could severely endanger personnel. Automatic fuel line safety shutoff as required by DOT regulations is not considered an automatic engine shutdown. [**1901**:A.12.2.1.3]

A.12.2.1.5.1 An increase in engine speed provides increased alternator output, increased engine cooling, increased air conditioner output, and increased output or performance from other devices that derive their power from the chassis engine. [**1901**:A.12.2.1.5.1]

A.12.2.1.5.2 The purpose of the interlock is to ensure that the chassis engine speed cannot be advanced without disengaging the driving wheels of the apparatus either at the transmission (having it in park or neutral) or by having a split shaft PTO fully engaged in the correct position to drive the component. [**1901**:A.12.2.1.5.2]

When manufactured, this vehicle was:
XX ft YY in. High
XX ft YY in. Long
ZZZZ tons GVWR

Changes in height since the apparatus was manufactured shall be noted on this label by the fire department.

FIGURE A.12.1.5.1 Suggested Label Showing Dimensions of Fire Apparatus.

A.12.2.2.1 Where a regular production model commercial chassis is used, it is recommended that the heavy-duty radiator option be included when such is available. [**1901**:A.12.2.2.1]

Where local environmental extremes exist — that is, high humidity and temperatures or extreme low temperatures — the purchaser should state specifically under what environmental conditions the apparatus is expected to operate. [**1901**:A.12.2.2.1]

A.12.2.2.2.2 It is important to have drain valves on the coolant systems of the apparatus for routine maintenance and repairs. The drain valve(s) should be located at low points in the system for complete drainage of the coolant. The design of the valve should be such that the valve will not inadvertently open from vehicle or engine vibration. It is also critical, especially on wildland vehicles or other vehicles subject to go off-road, that the drain valves are located out of the angle of approach or angle of departure or other areas where the valve could be subjected to damage. Accidental opening of or damage to the coolant drain valve could allow sudden loss of the engine coolant, causing severe or catastrophic damage to the engine. [**1901**:A.12.2.2.2.2]

A.12.2.3.1 Full-flow oil filters are mandatory with some diesel engines. [**1901**:A.12.2.3.1]

A.12.2.3.3(15) Tire cold pressure should be based on the tire manufacturer's load and inflation tables for the load to be carried and the rim pressure rating, not necessarily the maximum load at maximum pressure listed on the tire sidewall. [**1901:**A.12.2.3.3(15)]

A.12.2.3.3(16) Tire cold pressure should be based on the tire manufacturer's load and inflation tables for the load to be carried and the rim pressure rating, not necessarily the maximum load at maximum pressure listed on the tire sidewall. [**1901:**A.12.2.3.3(16)]

A.12.2.4 On a diesel engine, a manual emergency engine shutdown might be provided in addition to the normal engine shutoff switch. It could be of the type that will close off either the air supply or the exhaust gas flow of the engine. The activation mechanism should be provided with a guard and marked with a sign that reads "Emergency Shutdown." Provisions to prevent restarting of the engine without a special reset procedure should be included. [**1901**:A.12.2.4]

A.12.2.4.1 Caution needs to be used because air intake filters might affect the engine manufacturer's air restriction requirements. [**1901**:A.12.2.4.1]

A.12.2.4.3 The extent to which air inlet protection is required could depend on specific fire department operations. Departments operating in ember-rich environments, such as wildland fires, should consider specifying a multiscreen ember separator capable of meeting the test requirements defined in the Parker Hannafin, Racor Division, publication LF 1093–90, *Ember Separation Test Procedure*, or an equivalent test. Purchasers of apparatus utilizing commercial chassis should be aware that ember separators capable of meeting these test requirements may have a screen and housing externally mounted on or around the commercial chassis hood or bumper extension. [**1901**:A.12.2.4.3]

A.12.2.5.1.1 To prevent engine shutdown due to fuel contamination, dual filters in parallel, with proper valving so that each filter can be used separately, might be preferable. The purchaser should specify if dual filters are desired. Installation of two or more pumps should be designed so that failure of one pump will not nullify the performance of the other pump(s). It should be remembered that commercial vehicles are designed for over-the-road operation, and the fuel system and battery are at least partially cooled by the flow of air resulting from the motion. [**1901**:A.12.2.5.1.1]

A.12.2.5.1.6.1 With the use of diesel engines, the concern for vapor lock common with gasoline engines does not exist, and electric fuel pumps usually are not compatible for connection in series with a diesel engine fuel system. As a result, where an electric fuel pump is specified with a diesel engine, it is arranged as a fuel priming pump only. When not properly marked with a label or when the control valves are not properly set, the auxiliary priming system can cause the diesel engine to lose its prime. In addition, operation of a priming pump during diesel engine operation can boost fuel inlet pressure to the engine's fuel system. This could cause erratic engine behavior and loss of engine speed control. Control systems for priming pumps should allow only momentary operation and prevent the operation of the pump while the engine is operating. [**1901**:A.12.2.5.1.6.1]

A.12.2.6.1 Emissions from exhaust discharge pipes should be directed away from any fire-fighting tools, since such emissions contain an oily substance that could make the tools difficult to handle and possibly dangerous to use. [**1901**:A.12.2.6.1]

A.12.2.6.7 Exhaust temperature while the diesel particulate filter (DPF) is actively regenerating can reach 900°F to 1300°F (480°C to 704°C). The purchaser should be aware that these temperatures are much higher than normal engine idle exhaust temperatures. [**1901**:A.12.2.6.7]

Apparatus that make short runs with extended idle time might tend to build up soot in the DPF without giving the engine sufficient opportunity to passively regenerate. If the DPF light illuminates, the vehicle should be driven above 5 mph (8 km/hr) for a period of time to allow the DPF to regenerate either actively or passively, or it should be parked in a controlled area and a manual regeneration initiated. [**1901**:A.12.2.6.7]

Those fire departments that employ in-station exhaust venting equipment while performing DPF regeneration should consult their vent supplier to ensure that the vent system will handle any potential DPF active regeneration event or perform the regeneration outside while not connected to exhaust venting equipment. [**1901**:A.12.2.6.7]

A.12.2.6.7.1(1) The requirement for the DPF to automatically initiate only above 5 mph (8 km/hr) ensures that the exhaust gas temperatures will not change suddenly while the apparatus is parked. This will avoid situations where an apparatus is parked next to a curb and pedestrians are suddenly exposed to excessively hot exhaust gas. [**1901**:A.12.2.6.7.1(1)]

A.12.2.6.7.3 The DPF regeneration inhibit switch allows the operator to keep the DPF from regenerating during times when the apparatus is operating in an environment where extremely hot exhaust gas would be a hazard. [**1901**:A.12.2.6.7.3]

The inhibit function must be used carefully. Repeated use of the inhibit function can lead to soot buildup. Excessive buildup of soot can produce an uncontrolled burn inside the DPF, causing significant vehicle damage and dangerous exhaust temperatures. Watch the DPF indicator and provide opportunity to regenerate the DPF soon after using the inhibit function. [**1901**:A.12.2.6.7.3]

A.12.2.6.7.6 Exhaust system temperature mitigation devices might be required to meet the temperature requirement. Exhaust temperature mitigation devices might be affected by the addition of adapters commonly used to hook up to exhaust extraction equipment. The purchaser should ensure that this adaptation is certified by the manufacturer/installer of the adapter that it will not adversely affect the performance of the device. [**1901**:A.12.2.6.7.6]

Exhaust gas temperatures that meet this standard can ignite fine fuels, especially if a stationary DPF regeneration process is used. Exhaust system surface temperatures will exceed this requirement during a DPF regeneration and also can ignite fuels that are under the apparatus or caught on the underside of the apparatus. A site away from potential fuel sources should be selected for a stationary DPF regeneration.

A.12.3.1.2 Adequate braking capacity is essential for the safe operation of fire apparatus. This subject is normally covered in state highway regulations, but it should be noted that fire apparatus might have a special problem compared with normal vehicles of the same gross vehicle weight. Fire apparatus could have to make successive brake applications in a short period of time when attempting to respond to alarms with minimal loss of time. Thus, the problem of brake "fade" and braking capacity could be critical unless the brakes provided take into account the service requirements. Air-actuated brakes are recommended for fire service vehicles of over 25,000 lb (11,000 kg) GVWR.

Where air brakes are provided, it is important that they be of a quick buildup type with dual tanks and a pressure regulating valve. The rated compressor capacity should be not less than 12 ft^3/min (0.34 m^3/min) for this class of service. Air brakes require attention to guard against condensation in the air lines, such as might occur in areas subject to changes in climate that affect the moisture content of the air. Automatic moisture ejection of a nonfreezing type is recommended. Air pressure drop should be limited to normal air losses. The presence of either of the following conditions indicates the need for immediate service:

(1) Air brake pressure drop of more than 2 psi (14 kPa) in 1 minute with the engine stopped and service brakes released
(2) Air pressure drop of more than 3 psi (21 kPa) in 1 minute with the engine stopped and service brakes fully applied

A.12.3.1.3 There have been occurrences of a driver becoming disabled while driving a fire apparatus. The purchasers might want to specify the placement of the parking brake control to a location where it can be reached from the officer's seat or require a second control so the officer can stop the vehicle if the driver becomes disabled. Subsection 4.15.4 requires that the apparatus be able to maneuver up and down a 25 percent grade. If there is a need to park the apparatus on such grades and get out of the vehicles, the capability will have to be

designed into the parking brake system to park under these conditions.

A.12.3.1.4 Purchasers of fire apparatus with a GVWR less than 36,000 lb (16,330 kg) should also consider equipping the apparatus with an auxiliary braking system. Fire apparatus commonly make repeated stops from high speeds that cause rapid brake lining wear and brake fade, sometimes leading to accidents. [**1901:**A.12.3.1.4]

Auxiliary braking systems are recommended on apparatus that are exposed regularly to steep or long grades, operate in congested areas where repeated stops are normal, or respond to a high number of emergencies. [**1901:**A.12.3.1.4]

Examples of auxiliary braking systems include engine retarders, transmission retarders, exhaust retarders, and driveline retarders. These devices have various levels of effectiveness on braking. In addition, the systems can be activated by various means and settings, both automatic and manual in operation. The purchaser should carefully evaluate all auxiliary braking systems based on vehicle weight, terrain, duty cycle, and many other factors. [**1901:**A.12.3.1.4]

Some auxiliary braking devices should be disconnected when the apparatus is operated on slippery surfaces. Follow the auxiliary braking device manufacturer's recommendations for proper instructions. [**1901:**A.12.3.1.4]

A.12.3.1.4.2 Under poor traction and road conditions, the operator should turn off the secondary braking device to prevent the rear wheels from losing traction. This may not be needed on apparatus equipped with ABS, where the system will automatically disable the secondary braking device when it senses wheel slip.

A.12.3.2.1 Fire departments with vehicles that could be subject to continuous long-distance driving need to specify tire rating for continuous operation in place of intermittent operation. [**1901:**A.12.3.2.1]

A.12.3.2.2 Ground clearance dimensions are not intended to include the drive shaft(s) connections to an axle(s) that should meet the axle housing clearance requirements. All-wheel-drive or off-road vehicles normally require greater ground clearance. Also, the chassis manufacturer's ramp breakover angle should be maintained. When specifying the desired ground clearance, the purchaser should consider the terrain over which the vehicle is to be used.

For a wildland engine, ramp breakover angle is very important. No part of the fire package, such as the pump, should drag and become damaged when the apparatus is crossing water bars and other obstacles. Ramp breakover angle is not the same as ground clearance. The term *ground clearance* refers to the clearance all along the bottom of the vehicle, while the term *ramp breakover angle* is an inverted "V" between the front and rear axles. It is possible to add vertical exhaust pipes and skid plates without decreasing the ramp breakover angle.

A.12.3.2.3 The angle of approach or departure affects the road clearance of the vehicle going over short, steep grades such as would be found in a driveway entrance, crossing a high crowned road at a right angle, or in off-road service. Too low an angle of approach or departure will result in the apparatus scraping the ground. Figure A.12.3.2.3 shows the method of determining the angle of departure. The angle of approach (front of vehicle) is measured in the same fashion.

In Figure A.12.3.2.3, the line *AT* represents the circumstance in which the tailboard is the determining lowest point. The line *BT* represents a circumstance in which the tailboard is not the lowest point (in this case, the lowest point is a fuel tank). The angle of departure is shown as *XA* or *XB*. To determine the angle of departure, place a thin steel strip against the rear of the tires where they touch the ground or stretch a string tight from one rear tire to the other at the rear of where they touch the ground. Determine the lowest point (the tailboard, fuel tank, or other equipment or component) that would make the smallest angle of departure. Hang a plumb bob from the lowest point and mark the point on the ground where the point of the plumb bob touches. Measure the vertical distance from the ground to the point where the plumb bob was hung (*V*). Measure the horizontal distance from the plumb bob point to the front of the steel strip or to the string running from rear tire to rear tire (*H*). Divide the vertical distance (*V*) by the horizontal distance (*H*). The ratio *V/H* is the tangent of the angle of departure. If this ratio is known, the angle of departure can be determined from a table of trigonometric functions of angles or from a math calculator. The standard requires a minimum angle of departure of 20 degrees; since the tangent of 20 degrees is 0.3640, if *V* divided by *H* is 0.3640 or larger, the angle of departure is 20 degrees or greater.

A.12.3.3 Where automatic transmissions are used, the power takeoff (PTO) applications could present problems, especially where dual PTO drives are required. In some instances, the PTO drive can be engaged only in torque converter range, with resultant chances of overheating with prolonged use. If high engine rpm occurs, there is the possibility, if the vehicle is accidentally left in gear, of the output torque overcoming the parking brake and moving the vehicle. Proper operational instructions are essential with automatic transmissions.

A.12.3.3.3 If a 4 × 2, manual transmission–equipped chassis is to go 2 mph (3.2 km/hr), special gearing might have to be provided, such as a two-speed axle, an auxiliary transmission, or an extra low–geared transmission.

A.12.3.3.4 The purchaser can consider adding a device that will shift the transfer case from all-wheel drive back to standard 4 × 2 or 6 × 4 drive when the vehicle speed exceeds the manufacturer's recommended maximum speed for all-wheel drive operations.

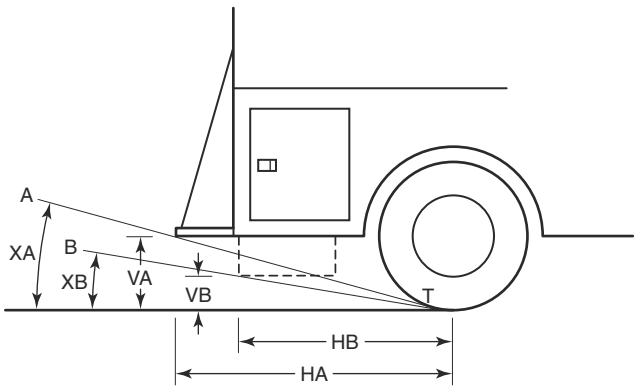

FIGURE A.12.3.2.3 Dimensions for Determining Angle of Departure.

A.12.3.4.1 Where a large-capacity fuel tank is desired, as in the case of apparatus designed for rural service, the capacity should be specified by the purchaser. [**1901:**A.12.3.4.1]

A.12.3.5 If the purchaser wants the hooks to be accessible without compartment doors having to be opened, the specification should state that fact.

A.13.1 This chapter defines the requirements for alternators, batteries, load management, and instrumentation to detect incipient electrical system failure. The intent is to require an electrical system that will operate the apparatus using power supplied by the alternator, shed nonessential electrical loads where necessary, and provide early warning of electrical failure in time to permit corrective action. [**1901:**A.13.1]

A.13.2.1 The 125 percent requirement for wiring and circuits is intended to provide reduced voltage drop over wire rated based on ampacity due to heating. In low voltage wiring, voltage drop becomes a problem before the thermal limit of current carrying capacity of a wire is reached. This requirement also ensures that the circuit protection will prevent damage to the wire in the event of a short or an overload. It is not the intent of this requirement to have the final-stage manufacturer replace the chassis manufacturer's original equipment wiring to meet the 125 percent requirement. It is also not the intent of this requirement to have electrical accessories purchased by the apparatus manufacturer rewired to meet the 125 percent requirement. Electrical device manufacturer–supplied wiring can be used to the point where it connects to the apparatus manufacturer's installed wiring. [**1901:**A.13.2.1]

A.13.2.6 It is the intent of 13.2.6 to provide a unique means of identifying a wire or circuit to prevent confusing it with another wire or circuit if electrical system repairs become necessary. If a color coding scheme is used instead of some other unique identification, that color should not be reused for a wire in any unrelated circuits within the same harness. However, 13.2.6 covers only low-voltage wiring and does not apply to shielded cables commonly used for communication purposes or wiring used in line-voltage circuits.

A.13.3.2 When the load specified in 13.3.2 is exceeded and larger alternators are not available, the purchaser and the manufacturer need to work together to determine how to reduce the minimum continuous electrical load to that which can be sustained under the conditions defined in 13.3.2.

The minimum alternator size is developed based on the loads required to meet the minimum continuous electrical load. Most apparatus will actually have loads exceeding the minimum requirements of this standard. The purchaser should review the maximum current output of the alternator versus the load study supplied for the apparatus from the manufacturer for on-scene and responding modes.

A.13.3.3(7) The purchaser should analyze the electrical loads that need to be maintained to fulfill the mission of the apparatus and define those loads for the manufacturer of the apparatus. The purchaser needs to understand, however, that there is a limit to the output capacity of an alternator system on the apparatus's engine and that this standard requires that the apparatus be capable of maintaining the minimum continuous electrical load under the conditions defined in A.13.3.2.

A.13.3.4 The unexpected shutdown of a fire apparatus at a fire can place fire fighters in mortal danger and seriously affect the fire attack. With computer-controlled engines and transmissions as well as electric valves and other controls, an electrical system failure could result in an immediate and total shutdown of the apparatus. The low-voltage monitoring system is intended to provide an early warning of an impending electrical failure and provide enough time to permit operator intervention. [**1901:**A.13.3.4]

A.13.3.6.1 Reduced crew sizes have forced the apparatus operator to assume many new fireground tasks in addition to that of operating an apparatus. Even if the operator is at the apparatus, he or she is too busy with higher priority tasks to pay much attention to monitoring the condition of the electrical system. [**1901:**A.13.3.6.1]

Electrical loads on modern fire apparatus frequently exceed the alternator capacity and can be supplied only by the deep discharge of the apparatus batteries. The high-cycle batteries that are designed to provide the large amount of amperage to crank modern diesel engines are severely damaged when deeply discharged. The automatic load management is intended to protect the electrical system from needless damage while maintaining the operation of essential devices. [**1901:**A.13.3.6.1]

It is important that the priority of all managed loads be specified by the purchaser so that, as electrical loads are disconnected from the apparatus's electrical systems, they are shed in an order least likely to affect emergency operations. The optical warning devices in excess of the minimum required in this standard can and should be load managed. [**1901:**A.13.3.6.1]

A.13.4 Batteries on fire apparatus should be larger than those used on commercial vehicles because, in addition to starting the vehicle, they need to provide the supplemental energy to power high-amperage, intermittent operation devices such as mechanical sirens and electric rewind hose reels. [**1901:**A.13.4]

Batteries usually have two ratings: “cold cranking amperes,” which determine the size engine that can be started, and “reserve capacity,” which provides a measure of the total power that can be provided at a much lower constant rate of discharge. Fire apparatus batteries should be sized to have enough cold cranking amperage and reserve capacity to restart the engine after being substantially discharged. [**1901:**A.13.4]

The purchaser might want to specify a battery disconnect switch for disconnecting the battery for maintenance or storage. This switch should be located where it cannot be operated from the driver's position. The chassis manufacturer should be consulted before such a switch is installed, because such an installation might affect the chassis warranty.

A.13.4.4.4 Overheating of a battery will cause rapid deterioration and early failure; evaporation of the water in the battery electrolyte can also be expected. Batteries in commercial chassis are often installed to take advantage of the cooling effect of the flow of air from motion in over-the-road operation and could be subject to overheating when the apparatus is operated in a stationary position, such as during pumping operations. [**1901:**A.13.4.4.4]

A.13.4.5 An onboard battery conditioner or charger or a polarized inlet should be provided for charging all batteries. The power cord from the onboard charger or battery conditioner should be plugged only into a receptacle protected by a ground-fault circuit interrupter (GFCI) at the shoreline origination point.

A.13.4.6 The purchaser might want to consider a second pilot light on the outside of the apparatus to warn that the master disconnect is on when the apparatus is parked in the fire station. [**1901:**A.13.4.6]

A.13.4.6.4 The purchaser might consider specifying that the indicator light dim automatically or be located in an area of the cab where it does not distract the driver when driving at night. The purchaser might consider a second "battery on" pilot light on the outside of the apparatus to warn that the batteries are on when the apparatus is parked in the fire station. [**1901:** A. 13.4.6.4]

A.13.4.7 Sequential switching devices are sometimes used to minimize the load placed on the electrical system during apparatus start-up for an emergency response. [**1901:**A.13.4.7]

A.13.7 SAE J551/1, *Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles, Boats (up to 15 m), and Machines (16.6 Hz to 18 GHz)*, provides test procedures and recommended levels to assist engineers in the control of broadband electromagnetic radiation and in the control of radio interference resulting from equipment installed on the apparatus. Adherence to the recommended levels will minimize the degradation effects of potential interference sources on fireground communication equipment or other devices susceptible to electromagnetic interference.

Procedures are included to measure the radiation from a single device or the entire apparatus. Compliance could be determined through actual tests on the completed apparatus or predictions based on tests previously conducted on similarly equipped apparatus. If compliance certification is required, it should be so indicated in the apparatus specifications.

A.13.8 In general, most fire apparatus are considered to be emergency vehicles and, as such, should be equipped with the optical warning devices described in this standard. One exception might be an apparatus that responds over long distances (i.e., over 100 miles) to a wildland fire without the need to call for the right-of-way from other traffic. If the purchaser wants to specify an apparatus without emergency lighting, care first needs to be taken to make sure that no conflict exists with local, state, or federal laws for the purchaser's jurisdiction. Even if emergency lighting is not required by state or federal law, it is still recommended that the apparatus be equipped with a system of amber flashers or rotating beacons.

A.13.8.1 The upper-level optical warning devices provide warning at a distance from the apparatus, and the lower-level optical warning devices provide warning in close proximity to the apparatus. *(See Figure A.13.8.1.)* [**1901:**A.13.8.1]

A.13.8.7.3 Under typical conditions, the specified optical warning system provides effective, balanced warning. In some situations, however, the safety of the apparatus can be increased by turning off some warning devices. For example, if other vehicles need to pass within close proximity to the parked apparatus, the possibility of distracting other drivers can be reduced if the headlights and lower-level warning lights are turned off. In snow or fog, it might be desirable to turn off forward-facing strobes or oscillating lights to reduce visual disorientation of the apparatus driver. [**1901:**A.13.8.7.3]

The intent of the warning light system is to provide full coverage signals through the operation of a single master switch when the apparatus is either responding or blocking the right-of-way. There is no intent to prevent the use of lower levels of warning when the apparatus driver believes such reductions are appropriate, given the vehicle's mission, the weather, or other operational factors. Additional switches downstream of the master switch can be specified by the purchaser to control individual devices or groups of devices. [**1901:**A.13.8.7.3]

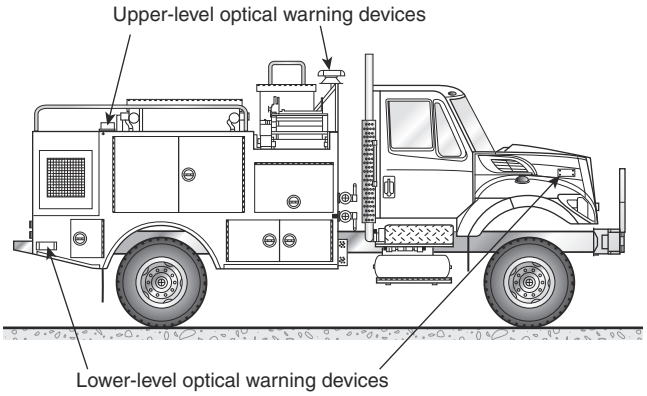

FIGURE A.13.8.1 Upper- and Lower-Level Optical Warning Devices.

Purchasers might want to specify traffic flow–type lighting such as amber directional indicators for use in alerting approaching motorists of blocked or partially blocked highways. [**1901:**A.13.8.7.3]

A.13.8.10 When a component such as a flasher or power supply is used to operate more than one optical source, the optical sources should be connected so that the failure of this component does not create a measurement point without a warning signal at any point in any zone on either the upper or lower level. Although a single optical source can be used to provide warning signals into more than one zone, the possibility of a total signal failure at a measurement point is increased when the same flasher or power supply is used to operate multiple optical sources, each providing signals into more than one zone. [**1901:**A.13.8.10]

A.13.8.12 Flashing headlights are used in many areas as warning lights and provide an inexpensive way to obtain additional warning to the front of the apparatus. Daylight flashing of the high-beam filaments is very effective and is generally considered safe. Nighttime flashing could affect the vision of oncoming drivers as well as make driving the apparatus more difficult. [**1901:**A.13.8.12]

In some jurisdictions, headlight flashing is prohibited or limited to certain types of emergency vehicles. If flashing headlights are employed on fire apparatus, they are to be turned off when the apparatus headlights are on. They should also be turned off along with all other white warning lights when the apparatus is in the blocking mode. [**1901:**A.13.8.12]

Steady burning headlights are not considered warning lights and can be illuminated in the blocking mode to light the area in front of the apparatus. Consideration should be given, however, to avoid shining lights into the eyes of oncoming drivers. [**1901:**A.13.8.12]

A.13.8.13 The minimum optical warning system should require no more than an average of 40 A for the operation of the upper-level and lower-level devices in the blocking mode.

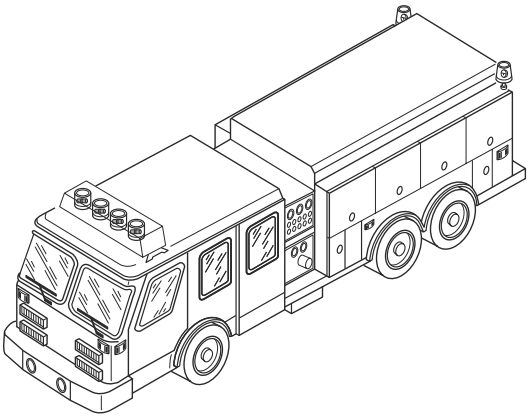

FIGURE A.13.8.13(a) Front and Left Side of Apparatus with Optical Warning System. [1901:Figure A.13.8.13(a)]

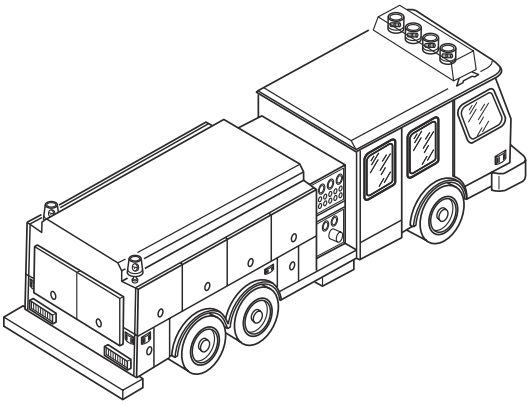

FIGURE A.13.8.13(b) Rear and Right Side of Apparatus with Optical Warning System. [1901:Figure A.13.8.13(b)]

On apparatus whose length requires midship lights, no more than 5 A of additional current should be required for the operation of each set of midship lights. Optical warning systems drawing more than 40 A might necessitate modification of the electrical system specified in Section 13.3 in order to supply the additional power required. [**1901:**A.13.8.13]

See Figure A.13.8.13(a) and Figure A.13.8.13(b) for illustrations of an optical warning system on a large fire apparatus. [**1901:**A.13.8.13]

A.13.8.13.5 The zone totals reflect the combined performance of the individual optical warning devices oriented as intended on the apparatus when viewed along the perimeter of a circle of 100 ft (30.5 m) radius from the geometric center of the apparatus. [**1901:**A.13.8.13.5]

The zone total is the sum of the optical power of all optical sources projecting signals of permissible color into the zone as measured at 5-degree increments along the horizontal plane passing through the optical center *H* throughout the 90 degrees included in the zone (19 data points). The calculation of zone totals assumes that all optical sources are mounted at the geometric center of the apparatus. With the optical center of each optical source oriented as installed, the optical power contributed by every optical source at a given point is taken from the test report, and they are added together to determine the total optical power at that point. The zone total is the sum of the optical power at the 19 measurement points in the zone. The upper- and lower-level optical sources are calculated independently. [**1901:**A.13.8.13.5]

The engineering basis of Section 13.8 permits both the design and the certification of an optical warning system by mathematical combination of the individual test reports for any number of optical warning devices of different color, flash rate, optical source, and manufacturer. [**1901:**A.13.8.13.5]

Using the test reports provided by the device manufacturer, the contribution of optical energy from each optical source is determined for every data point. The total candela-seconds per minute of optical energy is determined at each point, and then the zone totals are calculated and compared to Table 13.8.13.5. [**1901:**A.13.8.13.5]

A.13.8.14 The minimum optical warning system should require no more than an average of 35 A for the operation of the devices in the blocking mode. [**1901:**A.13.8.14]

A.13.8.16 In a few cases, a manufacturer might wish to type certify by actual measurement of the optical warning system on an apparatus. [**1901:**A.13.8.16]

Certification of the actual measurement of the performance of the optical warning system is made with each optical source either mounted on the apparatus or on a frame duplicating the mounting of the device on the apparatus. The performance of the system can be directly measured along the perimeter of a circle with a 100 ft (30.5 m) radius from the geometric center of the apparatus. Each optical warning device used should be certified by its manufacturer as conforming to all the requirements of this standard pertaining to mechanical and environmental testing. Photometric testing of the system should be performed by qualified personnel in a laboratory for such optical measurements. [**1901:**A.13.8.16]

The test voltages and other details should be as called for in this standard for the photometric testing of individual optical warning devices. The elevation of the photometer, however, could be set at the elevation that maximizes the performance of the upper-level devices and at a second, different elevation that maximizes the performance of the lower-level devices. [**1901:**A.13.8.16]

With the optical center of each device oriented as installed, the sum of the actual value of the optical power contributed by every optical source is then determined at each measurement point. The zone total is the sum of the optical power at the 19 measurement points in the zone. [**1901:**A.13.8.16]

Measurements are made to determine all the optical requirements of this standard, including the optical power at each of the required measurement points, the zone totals at the horizontal plane passing through the optical center, and the zone totals at 5 degrees above and 5 degrees below the horizontal plane passing through the optical center. Any upper-level warning devices mounted above the maximum height specified by the manufacturer(s) should be tested to demonstrate that at 4 ft (1.2 m) above level ground and 100 ft (30.5 m) from the mounted device, the optical energy exceeds 50 percent of the minimum required at the horizontal plane passing through the optical center. [**1901:**A.13.8.16]

A.13.9.1.2.2 If the purchaser wishes to have the siren controls within convenient reach of persons riding in both the right and

left front seat positions, that should be specified. In some apparatus, multiple control switches might be necessary to achieve convenient reach from the two positions. If other signal devices, such as an additional siren, bell, air horn(s), or buzzer are desired, the type of device and its control location also should be specified. [**1901:**A.13.9.1.2]

A.13.10 Depending on how the fire apparatus will be used, the purchaser may want to call for ground lighting, hose bed lighting, work surface and step lighting, interior lighting, or compartment lighting. The purchaser should specify where lights are desired and what level of performance is desired. For many of these lights, there is a problem with mounting them in a way that they will not be damaged by brush, equipment, or vibration.

A.13.12 The purchaser might wish to add camera(s) at the sides or rear of a vehicle with cab monitoring screens or automatic vehicle-stopping devices that sense an obstruction at the rear of the vehicle. In addition, angled backup lights mounted in the wheel well areas will provide additional scene lighting for personnel who might be at the side of the vehicle or lighting of folding tanks or other obstacles on the side of the apparatus. Any such devices will improve safety while vehicles are backing. [**1901:**A.13.12]

A.13.14.1 The purchaser might wish to have the entire low-voltage electrical system and warning device system certified by an independent third-party certification organization. [**1901:**A. 13.14.1]

A.14.1.3 The purchaser will need to define how many seating positions are required to carry personnel and might wish to specify the arrangement of the seating positions. Canopy cab extensions with patio door–type closures or separate telephone booth–type personnel enclosures are acceptable means for providing fully enclosed seating positions. The ultimate mission of wildland fire apparatus is dependent upon the apparatus responding to and arriving at incidents safely. To this end, it is essential that the wildland fire apparatus be driven in a safe manner and that all occupants are seated and belted while the apparatus is in motion. To encourage safe practices, fire department management should consider employing methods of monitoring driving and safety habits of the personnel onboard. Several methods of monitoring compliance of all safety precautions by personnel in the apparatus have been developed, including available live video monitoring, video recording, and vehicle data recording. Any monitoring method should include monitoring the use of seat belts and an indication of the characteristics of how carefully the apparatus is being driven. Purchasers may wish to consider specifying seat belt colors such as bright red or orange, which contrast with personnel clothing and thus are easier to observe for compliance. The purchaser may wish to consider specifying a Vehicle Data Record in accordance with NFPA 1901. This device can be used to keep track of seat belt use by personnel and monitor driving habits of the operator. This may be a useful tool for those departments struggling to enforce seat belt use policy.

A.14.1.3.1 The minimum effective belt length dimensions were determined from a survey of 300 fire fighters wearing bunker gear. For a lap belt only, the 95th percentile male fire fighter required 48 in. (1220 mm) of belt length, and the largest subject in the survey required 54 in. (1370 mm). The 60 in. (1525 mm) minimum will accommodate the largest subject and provide 12 in. (305 mm) spare for the 95th percentile subject. [**1901:**A.14.1.3.2]

A.14.1.3.2 For a lap and shoulder belt assembly, the 95th percentile fire fighter required 98 in. (2490 mm) of effective belt length, and the largest subject in the survey required 109 in. The 110 in. (2800 mm) minimum will accommodate the largest subject and provide 12 in. (305 mm) spare for the 95th percentile subject. [**1901:**A.14.1.3.2]

A.14.1.3.2.3 If the H-point of the seat is unknown, it can be estimated by the method outlined in A.14.1.7.1.

A.14.1.3.4 Some models of commercial vehicles with a GVWR of 19,500 lb (8,845 kg) or less do not have bright red or bright orange seat belts available. However, if seat belts meeting these requirements are commercially available on the required cab model, purchasers should consider specifying the bright red or bright orange color. Alternatively, a patch or slipcover might be available to make the seat belts more visible. [**1901:**14.1.3.4]

A.14.1.7.1 The H point is the mechanically hinged hip point of the torso and thigh on the devices used in defining and measuring vehicle seating accommodation in SAE J826, *Devices for Use in Defining and Measuring Vehicle Seating Accommodation*. It is an imaginary point located in two-dimensional space above the seat cushion. The H point is measured using a tool that simulates human hips and torso of a specific size and weight. The H point will vary with the size, shape, and material of the seat back, seat frame, and seat cushion. If the H point measurement is not available, it can be approximated by measuring 5 in. (130 mm) ahead of the seat back and 3 in. (75 mm) up from the nondepressed seat cushion surface. [**1901:**14.1.7.1]

Suspension-style seats have been developed for long-haul truck operations where the operator is driving for many hours at a time. Acceleration and braking are controlled, with an eye to fuel economy. The suspension-style seat in this duty profile provides a smoother ride and reduces fatigue from long hours in the seats. In contrast, the operator of a fire apparatus typically is making short runs with fast acceleration, quick maneuvers, and sudden braking. The bouncing motion of the suspension seat could hinder the driver's ability to maintain precise control of the throttle, brake, steering wheel, and other driving controls. [**1901:**14.1.7.1]

Selection of seating options should be made with consideration to the frequency of time that the driver will spend in the vehicle each day, and whether the fire department standard operating procedure (SOP) requires or encourages the occupant of the seat to be equipped with headgear during firefighting operations. The use of headgear reduces headroom and increases the chance of injury should the vehicle encounter unexpected road undulation or speed bumps. The effect of such road conditions during high-speed operation might be intensified by the action of a seat suspension. Potential for injury is greatly increased by failure to use or properly adjust the seat belt.

Proper seat adjustment is another issue that should be addressed by the fire department SOPs if apparatus are equipped with suspension seats. Too much pressure in a suspension seat air bag will reduce static headroom height and will negate the potential benefits of the suspension. Too little pressure will cause the seat to bounce excessively. The proper amount of pressure is dependent on the weight of the occupant. Departments where multiple drivers share an apparatus should recognize that adjustments need to be made between each shift. Seat adjustment should not be postponed until the driver is exiting the station on the way to a call. [**1901:**14.1.7.1]

A.14.1.7.4 The minimum seat head height values in this standard assume that the occupants are not wearing fire helmets. The use of a helmet puts the occupant at greater risk of neck or back injury during a rollover or a severe road event. [**1901:**A.14.1.8.4]

A.14.1.9.1 SCBA units and other equipment stored in the crew compartment can cause injuries to occupants of the compartment if they fly around the compartment as the result of an accident or other impact. Departments should check their pack and bottle weight to ensure that it does not exceed the published rating of the SCBA holder to be provided. [**1901:**A.14.1.9.1]

A.14.1.9.1(4) A new holder can be employed for each test. [**1901:**A.14.1.9.1(4)]

A.14.3.1 With the requirements for fully enclosed driving and crew compartments, the potential for heat buildup in these areas is greater. The purchaser should be aware of this condition and might wish to specify ventilation fans or air conditioning to keep the ambient temperature in the driving and crew compartment(s) lower. [**1901:**A.14.3.1]

A.14.3.2 The U.S. standards developed by SAE and the United Nations ECE regulation mirror each other except that SAE J2422 requires a roof preload impact prior to the roof crush. The ECE standard was established in 1958, while the SAE standards did not add performance criteria until 2003. Both the SAE and ECE standards are viable minimum measures of cab integrity. Manufacturers may test in excess of the standards. [**1901:**A.14.3.2]

A.14.3.4 The purchaser should realize that local conditions or operating procedures could cause the passenger to project into the sight pattern of the driver and therefore cause vision obstructions. Seats should be arranged so that SCBA and any passengers wearing protective clothing do not cause vision obstructions. Movement of the passenger should be considered when installing radios, computers, and other equipment so that forward movement or shifting is reduced to a minimum and does not block the driver's vision. [**1901:**A.14.3.4]

When specifying new apparatus, the purchaser should consider remotely controlled mirrors, especially on the passenger side. The location and mounting of the mirrors should not be placed where door pillars or other obstructions block their view. The location and mounting should be placed so warning lights do not reflect in the mirror to blind the driver's view. The location and mounting should not be placed so that the driver must look through the windshield area that is not wiped by the windshield wiper when viewing the passenger side mirror. Convex and other secondary mirrors should be considered to eliminate blind spots not covered by primary mirrors. Where necessary, heated mirrors should also be considered. [**1901:**A.14.3.4]

The purchaser should consider specifying a style of mirror that swings when making contact with branches and trees.

A.14.4 Typically, while engaged in fire-fighting operations on structural fires, apparatus and personnel are positioned in a safe location and hose is extended as necessary to discharge water or suppressants on the combustible material.

In wildand fire suppression, mobile attack is often utilized in addition to stationary pumping. In mobile attack, sometimes referred to as pump-and-roll, water is discharged from the apparatus while the vehicle is in motion. Pump-and-roll operations are inherently more dangerous than stationary pumping because the apparatus and personnel are in close proximity to the fire combined with the additional exposure to hazards caused by a vehicle in motion. The personnel and/or apparatus could be subject to injury or damage due to accidental impact, rollover, and/or environmental hazards, including burn over.

To mitigate the increased risk inherent with pump-and-roll operations, the following tactics are recommended:

(1) Driver is located inside the apparatus in a seated, belted position within the enclosed cab. Fire fighter(s) located outside the cab, walking alongside the apparatus, in clear view of the driver, discharging water with a short hose line.
(2) Driver and fire fighter(s) are located inside the apparatus in a seated, belted position within the enclosed cab. Water is discharged via a monitor or turret that is controlled from within the apparatus.
(3) Driver is located inside the apparatus in a seated, belted position within the enclosed cab with one or more fire fighters seated and belted in the on-board pump-and-roll fire-fighting position as specified in Section 14.4.
(4) Driver and fire fighter(s) are located inside the apparatus in a seated, belted position within the enclosed cab, but water is discharged with a short hose line or hard line out an open cab window.
(5) And under no circumstances is it ever considered safe practice to ride standing or seated on the exterior of the apparatus for mobile attack other than seated and belted in an on-board pump-and-roll fire-fighting position. *(See Section 6.3 of NFPA 1500.)*

The on-board pump-and-roll fire-fighting position should only be used when the following conditions are met:

(1) The apparatus is actively engaged in mobile attack on the fire line.
(2) The fuel model is characterized as fine fuels.
(3) The ground is level, flat and free of obstacles.
(4) Driver visibility is unobstructed.
(5) Vehicle speeds are no greater than 10 mph.
(6) Fire fighter is wearing full protective NFPA 1977–compliant personal protective equipment and is equipped with a fire shelter.

A.14.4.3.4 This is to protect against objects such as limbs entering the seating enclosure. Woven wire cloth with ¼ in. (0.6 cm) diameter wire spaced at 1¾ in. (4.4 cm) on centers is commonly used in the forestry industry to provide this protection.

A.15.1 Compartmentation that is designed to meet the size, shape, and weight requirements of special equipment might be required. Any special equipment to be carried on the apparatus should be identified in the specifications. [**1901:**A.15.1]

A.15.1.1 A water tank can condense water on the outside. Ventilation and drainage should be provided in compartments sharing a common wall with a water tank.

A.15.3.1 Fire-fighter injuries resulting from climbing on apparatus to retrieve, store, and operate equipment can be minimized if specifications require that equipment be accessible from ground level. Examples of ways to reduce the need to climb on the apparatus include, but are not limited to, using