Report on Application of New Technology to Modern Fire Apparatus

Preface

By 1975, the date which marked the birth of the United States Fire Administration (USFA), and shortly after release of the America Burning report, the North American Fire Service responded to public demand by broadening its response obligations to include a variety of emergency situations which required advanced technologies and improved functionality of fire apparatus and related equipment. Since that time, North America's fleet of fire apparatus has aged dramatically and, in many cases, existing equipment cannot continue to efficiently, functionally and safely support the expanded role and increased demands placed upon fire service organizations.

The Fire Apparatus Manufacturers' Association (FAMA) is comprised of over 115 member companies that design, manufacture and market automotive fire apparatus and related equipment in the United States and Canada. Established in 1946, FAMA members have been committed to the development of technologically advanced fire apparatus and fire suppression equipment, and have worked tirelessly to improve the safety, performance and functionality of such equipment. This "White Paper" report was prepared by FAMA, through the input of its member companies, for the benefit of all North American Fire Service agencies that provide public fire protection to citizens in their communities. The report is organized into sections that summarize specific improvements and added features related to aerial, body, chassis, electrical, pump, and general. The report will be updated periodically as changes are incorporated into the NFPA 1901 Standard for Automotive Fire Apparatus, or when technological advances provide substantial improvements in the safety and functionality of fire apparatus.

This report is intended to serve as a resource for fire service administrators who are considering replacement of outdated or obsolete fire protection equipment, or who are in the process of purchasing new equipment. It has been formatted to facilitate flexibility in support of these administrators who need to present expenditures and budget justification to their sources of funding. In each section, specific new features have been itemized and paired with a description of particular benefits derived from each feature or technological improvement. The features are further distinguished as to when the new technology was developed, and whether the new feature is now required under updated NFPA Standards. In addition, each feature is categorized as related to improved safety, service, durability, or performance of the apparatus. Using the "cut and paste" feature in Adobe Acrobat or Excel, the user is invited to easily incorporate the data contained in this report for constructing an effective presentation that is suited to a variety of applications.

FOREWORD

The Fire Apparatus Manufacturers' Association (FAMA) takes great pride in presenting this "Fire Apparatus Improvement White Paper" to the North American Fire Service. FAMA believes this report can be used as a resource tool for determining and justifying funding requirements, and can assist the forward-thinking fire service administrator in analyzing the department's future equipment needs. The data contained in this report was gathered by FAMA members for informational purposes only; it is not intended to promote or endorse a particular product or manufacturer. FAMA welcomes your comments on this report, its format, and its utility to the fire service community.

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FIRE APPARATUS IMPROVEMENT WHITE PAPER

Report on Application of New Technology to Modern Fire Apparatus

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A little over twenty (20) years ago, while many of us were responding to fire and rescue emergencies in open cab fire apparatus with steel bodies and roof-mounted sirens, a committee of thirty (30) fire officers, fire industry professionals and at-large experts under the regimentation of the National Fire Protection Association (NFPA) were busy identifying ways to improve fire apparatus from standpoints related to safety, service, extended durability and performance.

With the release of the 1991 edition of NFPA 1901, the document that showcases the standards for automotive fire apparatus, the fire industry went from the reactive mode of incorporating into the standard features and design characteristics resulting from any number of prior events to an offensive posture in seeking out and embracing emerging technologies that improved fire suppression; tempered differing theories of fire apparatus composition and steadfastly – and most importantly – addressed "safety" – for the fire fighters that operate the vehicles, and the public that demands safe operating vehicles.

Rollover stability control or apparatus that meets new rollover stability criteria is now mandatory under the new standard.

Beginning with the 1991 standard, the fire service began to see a greater use of aluminum and stainless steel in body manufacturing. The traditional open cab was no longer permitted and slow-close valves were standardized. Automatic transmissions were required for chassis cabs for ease-of-use among a vast array of drivers. Weight and balance became a key design criteria and line-voltage electrical systems were upgraded.

The work, the research, the consideration of better and improved methods did not stop there.

Five years later, the 1996 standard brought more improvements with air systems, standards for Quint apparatus, and the disappearance of sealed-beam warning lights in the face of rigid 12VDC load management requirements. The industry was introduced to the term "candela-seconds of light" as optical warning devices became scientifically integrated into the standard. In other words, the fire service standards for new fire department apparatus were now entering the world of advancing technology that could be measured and validated, something the fire service did not have in the past.

In 1999, manufacturers began to include slip-resistant ratings as diamond plate used for stepping surfaces needed to have aggressive tread for slip and fall protection. Pre-delivery testing requirements were outlined to ensure apparatus met critical operational requirements of the purchaser.

With the 2003 standard came further movement toward the common goal of safety with reflective striping required for the inside of open cab doors, the mandatory use of inlet relief values, third-party testing of generators, and the use of a standardized equipment weight table.

Much like the preceding documents, the 2009 standard of NFPA 1901 does not disappoint in further advancing the mantras of safety, service, durability, and performance.

After considerable input from interested fire service professionals, evaluation of scientific testing, qualified judgments by experienced fire officers and manufacturers, and plain old common sense, the just-released version of the 1901 standard is yet another benchmark in the continuation of ensuring fire apparatus today are designed, engineered and equipped to meet an ever-changing mission-profile of the fire service.

As you no doubt will see in the accompanying list, the new standard addresses one-hundred sixty-three (163) different changes, additions or amendments to the previous standard, of which more than one-hundred relate to safety.

For example, NFPA 1901 now mandates on-board Vehicle Data Recorders, or VDRs. In commercial aircraft, you know these as the fabled "black box." With VDRs, operational dynamics of the apparatus are recorded on a 48-hour loop and must have a capacity to collect data for the most recent 100 engine hours.

In the event of an incident, or near-miss incident, using software provided with the system, a chief or department officer can download critical data in terms of date, time, vehicle speed, engine speed, ABS event, seat belt

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status and several other characteristics of the vehicle during its operation up to the point of a specific event.

Roll over stability control or apparatus that meets new rollover stability criteria is now mandatory under the new standard. Apparatus manufacturers must be able to ensure the stability of the vehicle by one of three methods. The most verifiable way to assure vehicle stability at unusual angles will be to tilt-table test the finished apparatus to a minimum of a 26.5° angle. Manufacturers may also mathematically calculate a vehicle's center-of-gravity or provide a stability control system that is built into the apparatus chassis.

Apparatus with a GVWR above 26,000-lbs. shall be geared to a maximum top speed of 68 MPH. Vehicles above a 50,000-lb. GVWR will have restricted gears for a 60 MPH maximum. A tire air pressure monitoring system is now required on all new apparatus. A secondary braking system shall be required for all vehicles with greater than a 36,000-lb. GVWR.

Fire departments will be required to carry one (1) traffic vest for each seating position on the apparatus; five (5) fluorescent orange traffic cones; five (5) illuminated warning devices and a single AED (or Automatic External Defibrillator), which can be met if a monitor/defibrillator on an Advanced Life Support engine or rescue is present. The apparatus manufacturers are not required to provide this equipment with new apparatus, so you must be certain you obtain and install each of these items on your new apparatus to ensure compliance with the standard.

Plumbing must meet specific hydrostatic testing requirements; amended waterway performance criteria are outlined; improvements to paint processes are noted; and a generator load requirement determination must be made when specifying for a specific line-voltage system.

There are two (2) requirements now in the standard that are bound to considerably raise eyebrows.

First, helmets are no longer permitted to be worn in the cab when the vehicle is in motion as a means to improve neck safety in the event of an accident. Stowing helmets inside the cab must comply with requirements outlined in Section 14. A seat belt alarm enunciator panel for all seating positions must be installed. Belts must be either red or orange in color to prevent misidentification with SCBA straps.

Second, and the requirement that has created the most discussion amongst fire service professionals, is the mandate that European-style chevron striping be affixed to the back of all new apparatus to improve the conspicuity of apparatus to on-coming traffic. Not only is the requirement stated clearly, so too are the colors that must be used, with red being the dominant color and either yellow or fluorescent yellow-green as the accompanying color.

Relative to the chassis, there must be visibility of the diesel particulate filter (DPF) from outside the cab area and shall (a) regenerate automatically by the engine, and (b) be capable of being manually activated through a switch in the cab. Apparatus exhaust temperatures must not exceed 851°F with exhaust having to be discharged horizontally and not down and deflected off the ground.

Finally walkway, compartment and step lighting optical output will increase from one foot-candle to two. Apparatus weight ratings shall be calculated to include 250-lbs. per person per seating position on the apparatus.

You are encouraged to use the accompanying list of revisions and additions to the NFPA 1901 standard when communicating with your municipal administrators relative to budgetary and mission-readiness needs. As with previous editions of the FAMA White Paper, this update contains a Feature/Feature Change/Benefit summary that is further categorized as being an improvement to one of four subjects: Safety, Service, Durability and Performance.

From the information contained in this report, it is obvious that improvements in apparatus design, safety and functionality are readily apparent. While change does temper tradition, a look back over the last twenty (20) years of revisions to the NFPA 1901 standard should serve to confirm that these are not changes made for change sake, but for ensuring the safety of our firefighters and our collective preparedness to respond to emergencies in a new climate with technically-enhanced apparatus designed to provide a safe response, durable life, and service to the communities they serve.

The Fire Apparatus Manufacturers' Association (FAMA) is made up of 115+ of the industry's apparatus and component manufacturers. As it has in years past, FAMA is producing the attached White Paper spreadsheet as a critical, must-read resource for fire executives and apparatus committee members who engage in the apparatus specification process. Wading through the technical complexities of developing a new apparatus specification can be daunting. Determining how best to meet operational and functional needs with a new vehicle while remaining within the scope of the now-established consensus standard is imperative. ●

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Category	Feature	Feature Change	Benefit	NFPA 1901 2009 Edition Requirement	Approximate Year Introduced	Safety	Service	Durability	Performance
Aerial	Breathing Air	Aerial Mounted Breathing Air Standards	Uniform construction standard. Low air warning system. Air duration improved. Serviceability improved.	Chapter 25	1999	X	X		X
Aerial	Controls	Aerial Mutiplex Systems	Aerial information display. Serviceability improved. Envelope control avoids collision damage.		1999	X	X	X	X
Aerial	Controls	Aerial Tip Controls	Control ladder at tip for better firefighter control.	20.5.4	1999	X			X
Aerial	Controls	Short Jack Limitation	Range of operation defined. Narrow street and alley accommodation. Tip-over potential reduced.	20.17.5	1999	X			X
Aerial	Ladder Testing	Expanded aerial and ground ladder testing standards	Uniform test standards. Third party test recommendations. Documentation and verification of performance.	20.22	1996	X		X	X
Aerial	Load Chart	Overload Documentation	Informs operator of potentially unsafe operating conditions.	20.3.4	1996	X			
Aerial	Operation	Slide Mechanism	Smoother operation. Serviceability improved. Durability improved.	20.5.3	1999	X	X	X	X
Aerial	Operation	Tip Camera	Remote aerial observation possible. Observation of remote controlled fire streams. Safer observation of fire ground scene.		1999	X			X
Aerial	Plumbing	Pinable Waterway	Protects waterway in rescue operations.		1991	X		X	X
Aerial	Plumbing	Remote Waterway Nozzle Controls	Remote control of tip mounted water nozzle. Risk to firefighters reduced.	20.6.1	1999	X			X
Aerial	Plumbing	Waterway Performance	Improved range of stream. Faster fire knock down. Fewer appliances required.	20.6.1	1996	X			X
Aerial	Safety Interlocks	Aerial Interlocks	Interlocks to reduce possibility of operator error. Safety ensured.	20.17	1996				
Aerial	Safety Interlocks	Safety Interlock Expansionw	Unsafe operating conditions avoided. Automatic operation.	20.17.5	1991	X			
Aerial	Slip Resistance	Rung Surfaces	Firefighter Safety Improved. Consistent footing service. Slips during inclement weather avoided.	20.2.5	1999	X			
Aerial	Strength	Tip Load Standard	Uniform performance standard established. Increased minimum performance.	20.3	1991	X			X
Aerial	Structure	Structural Safety Factors	Testing and inspection definition improved. Welding and weld inspection standards specified.	20.22.3	1999	X			
Aerial	Warning Device	Aerial Stabilizer Warning	Provides audible and visual warning of stabilizer movement and deployment.	20.21.4.1.1 20.21.4.1.2	1996	X			
Body	Access	Handrails, Steps, & Ladders	Access improved with build-in steps. Three-point access provided.	15.7.1.4 15.8.5	1999	X			X
Body	Access	Lighted Handrails	Safety improved for night operation.		2004	X			X
Body	Body and Tank Integration	Shaped Tanks	Equipment storage space improved. Special equipment storage possible. Through-tank ladder storage.		1999	X			X
Body	Body Mounting	Body Mounting Isolation	Body life extended by decreasing stress, vibration, and shock.		1991		X	X	X
Body	Breathing Air	Enclosed SCBA Bottle Fill Station	Improved safety during cylinder refills.	25.9	1999	X			
Body	Command Centers	Slide-Out Sections	Command center room increased.		1996	X			X
Body	Compartment Doors	Powered Doors and Door Locks	Security, reliability, and durability improved.		2003	X			X
Body	Compartment Doors	Compartment Door Hardware	Increased reliability, durability and safety.		1991	X		X	X
Body	Compartment Doors	Door Seals Improved	Weather resistance improved.		1991		X	X	X
Body	Compartment Doors	Rollup Door Offerings	Equipment access improved. Door damage risk reduced.		1996	X	X		X
Body	Compartments	Ventilation	Equipment kept drier. Equipment life extended.		1991			X	
Body	Equipment Mounting	Equipment Storage Devices	Organization of tools for rapid deployment.		1991			X	X
Body	Equipment Mounting	Powered Equipment Racks	Ergonomic access to ladders, suction hose, etc… Compartments free for other uses.	15.4	1999	X			X
Body	Equipment Mounting	Through-Tank Ladder Storage	Ergonomic access to ladders. Allows high-side compartments both sides.		1999	X			
Body	Ground Ladder Mounting	Requirements for Mounting of Ground Ladder Mounting	Provides clear definition for mounting of ground ladders. Protects against unneccesary wear or damage.	15.11	2009	X	X	X	
Body	Hose Storage	Hose Storage Security	Prevents hose from falling off of truck during road travel.		2005	X			
Body	Hose Storage	Lower Hose Bed Height	Ergonomics improved. Risk of injury reduced.		1999	X			
Body	Hose Storage	Extendable Hose Storage	Improved ergonomics. Risk of injury reduced. Faster re-packing time.		2003	X			X
Body	Material	Stainless Steel Bodies	Corrosion resistance improved.		1991		X	X	X
Body	Material	Composite Bodies	Plastic, polypropylene, and composites. Corrosion resistance. Lighter Weight.		1999		X	X	X

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Category	Feature	Feature Change	Benefit	NFPA 1901 2009 Edition Requirement	Approximate Year Introduced	Safety	Service	Durability	Performance
Body	Miscellaneous Equipment	Additional Safety Equipment	Requirements for additional safety equipment on all Fire Fighting Apparatus. Including AED's, Safety Vests, Traffic Cones…	In Chapters 5, 6, 7, 8, 9, 10, and 11	2009	X			
Body	Multifunctional Bodies	Rescue-Pumper Combinations	Rescue response efficiency improved.		1991				X
Body	Receiver Tubes	Receivers and anchor requirements	Increase in the Safety Factor. Increase in capability	15.12.1 15.12.2	2009	X	X	X	X
Body	Service Access	Pump Enclosure Access Panels	Ease of maintenance and serviceability.	15.6	1991		X		
Body	Trailer Requirements	Trailer Standard	Trailers are identified as special units with some of their own criteria.	26	2009	X	X		X
Body	Visibility	Chevron Stripping	Provides definition for conspicuity at the rear of the vehicle. Provides consistency for Fire Vehicle identification	15.9.3.2	2009	X			
Chassis	Audible Warning Devices	Noise Levels Reduced	Sirens, speakers, and air horns off roof. Noise levels in the cab reduced. Crew communications improved.	13.9.2	1991	X			X
Chassis	Brakes	ABS Mandated	Vehicle control improved during emergency braking.		1996	X		X	X
Chassis	Brakes	Air Disk Brakes	Stopping distance reduced. Brake fade eliminated.		1990	X	X	X	X
Chassis	Brakes	Auxiliary Brake Mandated	Stopping capability improved. Operator control improved. Brake life increased.	12.3.1.4	1996	X	X	X	X
Chassis	Brakes	Roll Stability Control	Brakes applied based on aggressive cornering. Reduces potential for roll-over.	4.13	2005	X			X
Chassis	Brakes	Electronic Stability Control	Brakes applied based on steering wheel inputs. Improves control of vehicle during emergency braking.	4.13	2007	X			X
Chassis	Cab	Aluminum Cab Construction	Weight reduced. Payload increased. Durability improved.		1991	X		X	X
Chassis	Cab	Cab Integrity	Cab integrity standards mandated Roof Crush Integrity Front Cab Crush Integrity	14.3.2	2009	X			
Chassis	Cab	Electric Windshield Wipers	Performance consistency improved over air driven units.		1991	X	X	X	X
Chassis	Cab	Noise Levels	Communication improved. Crew comfort improved.	14.1.7	1991	X			X
Chassis	Cab	Tilt Cab Design	Maintenance access improved.	14.2	1991		X		
Chassis	Cab	SCBA Storage	Positive Engagement Designs Required Ensured SCBA Retention in Crash	14.1.10	2003	X			X
Chassis	Conspicuity	Door Reflective Material	Conspicuity of vehicle increased with doors open. Visibility of door access improved.		2003	X			
Chassis	Engine	Electronic Engine Controls	Electronically controlled pressure governor possible. Maintenance intervals increased. Higher horsepower and torque possible. Mechanical throttle linkage eliminated. Service diagnostics provided. Emissions reduced. Fuel economy improvement.		1994				X
Chassis	Engine	Mid-Engine Chassis	Cab noise level reduced. Cab room improved.		1990	X			
Chassis	Exhaust	Exhaust Temperature Mitigation	Exhaust tailpipe temperatures reduced	12.2.6	2009	X			
Chassis	Exhaust	Diesel Particulate Filter	Eliminates exhaust smoke Cleaner Environment	12.2.6	2009	X			
Chassis	Occupant Protection	Side Roll Protection	Risk of injury reduced during roll event.		2003	X			
Chassis	Occupant Protection	Frontal Occupant Protection	Risk of injury reduced during frontal crash.		2008	X			
Chassis	Occupant Protection	Red or Orange Seat Belts	Visibility of belts increased. Seat belt compliance enforcement simplified.	14.1.3.4	2003	X			
Chassis	Occupant Protection	Seat-Integrated Seat Belts	Can improve ease of use		2003	X			
Chassis	Occupant Protection	Dual-Retractor Seat Belts	Can improve ease of use		2008	X			
Chassis	Occupant Protection	Vehicle Data Recorder	Provides Fire Chief with a record of who is wearing their seat belts and how they are driving.	4.11	2009	X			
Chassis	Occupant Protection	Enclosed Cab	Crew safety. Firefighter rehabilitation area. Working conditions improved. Crew comfort improved. Communication improved.	14.1.1	1991	X			X
Chassis	Occupant Protection	Equipment Mounting	Items in Cab Must be Secured Safety Improved during Crash	14.1.11	1996	X			
Chassis	Occupant Protection	Shoulder Harness Seat Belts	Type II shoulder harness required for outboard seating positions. Safety increased during crash.	14.1.3.5	1999	X			
Chassis	Occupant Protection	Seat Belt Length	Minimum belt length established. Accomodates large fire fighters with bunker gear on.	14.1.3.2	2009	X			
Chassis	Occupant Protection	Seat Belt Warning Device	Display shows who is belted and who is not. Visible to Driver or Officer	14.1.3.10	2009	X			
Chassis	Safety Interlocks	Chassis PTO Interlock	Improved safety with consistent performance of interlock functions.	12.2.1.5.2	1996	X			X

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Category	Feature	Feature Change	Benefit	NFPA 1901 2009 Edition Requirement	Approximate Year Introduced	Safety	Service	Durability	Performance
Chassis	Seating	Head Clearance	Head clearance for suspension seats increased. Head clearance for fixed seats increased. Safety improved.	14.1.8	2003	X	X		X
Chassis	Seating	Helmet Storage	Designated Helmet Storage Safety Improved During Crash	14.1.8.4	2003	X			
Chassis	Seating	Seat Adjustment	Seat adjustment criteria. Seat adjustment time criteria.	14.1.8	2003	X			
Chassis	Steering	Steering Geometry	Steering cramp angles increased. Turning radius reduced. Bump steer reduced.		1999				X
Chassis	Steering	Tilt and Telescopic Steering Column	Steering ergonomics improved.		1991	X	X		X
Chassis	Suspension	Air Ride Suspension	Ride quality improved. Height adjusts to load. Body structure sees less shock.		1991	X		X	X
Chassis	Suspension	Independent Front Suspension	Ride quality improved. Cornering stability improved. Cab structure sees less shock.		2001	X		X	X
Chassis	Suspension	Taper Leaf Front Springs	Improved ride quality.		1999	X	X	X	X
Chassis	Tire Chains	Automatic Engaging Tire Chains	Tire traction in adverse weather conditions improved through automated activation without stopping the vehicle or leaving the operator's position.		1991	X		X	X
Chassis	Tires	Truck Tire Improvements	Rubber compounds improved for greater tread wear. Casing life improved. Load capacities increased.		1991	X		X	X
Chassis	Tires	Run-Flat Device	Allows safe steering control during tire blow-out		2005	X			
Chassis	Tires	Tire Pressure Monitor	Method of tire pressure monitoring required. Safety improved through correct tire pressure.	4.13.4	2009	X			
Chassis	Transmission	Electronic Transmission Controls	Shift performance improved. Service diagnostics provided. Engine communications capability.		1992	X	X	X	X
Chassis	Vehicle Stability	Rollover Stability Standards	Minimum standards set for roll stability or the vehicle must be equipped with electronic stability control.	4.13	2009	X			X
Chassis	Visibility	Rear Vision Monitors	Safety during backing improved. Blind spots reduced.		1999	X			
Chassis	Visibility	Mirror Remote Adjustment	Mirrors must be adjustable from Driver position. Improved safety and convenience	14.3.5	2009	X			
Chassis	Wheels	Hub Piloted Wheels	Wheel nut torque reduced. Centering of wheel improved. Wheel balance improvements reduce vibration.		1999	X	X		X
Electrical	Air Systems	Equipment Access	Easy access to air system electrical equipment eases operation and maintenance.	24.2.10.1(2)	2009	X	X		X
Electrical	Audible Warning Devices	Siren Standards	Audible warning standards established.	13.9	1996	X			
Electrical	Batteries	Battery Conditioner	Battery life improved. Maintenance requirements reduced. Consistent battery condition maintained.	13.4.5	1991	X		X	X
Electrical	Circuits	Electromagnetic Interference Suppression	Systems less susceptible interference from communication equipment.	13.7	1991		X	X	X
Electrical	Circuits	Multiplex Control Systems	Wire harnesses simplified. Diagnostic capability. Flexible configuration of systems. Fewer connections. Serviceability and troubleshooting improvement. Reliance on relays reduced. Safety interlock capability improved.		1999		X	X	X
Electrical	Generators	Generator Size Calculation	Method to determine the minimum size generator required to power desired loads.	A.22.1	2009	X			X
Electrical	Generators	Low Oil Shutdown	Safety shutdown to prevent damage or catastrophic failure of the generator	22.5.3.2	2009	X	X	X	X
Electrical	Generators	Output Waveforms	If the AC power output waveform is generated electronically, it may be a modified or pure sine wave. Some equipment may not operate properly with a modified sine wave. The appendix provides information on equipment that may not operate properly.	22.5.10, A22.5.10	2009			X	X
Electrical	Generators	Generator Testing	Recording the voltage and frequency at the lowest allowed engine speed verifies the generator operates properly at this engine RPM.	22.15.7.3.5	2009	X	X	X	X
Electrical	Generators	Generator Testing	Third party testing of portable generators (attached to fixed wiring on the vehicle) provides verification that the generator operates as stated.	22.15.7	2009	X	X	X	X
Electrical	Generators	Generator Design	Size reduced. Noise levels reduced. Power ratings based on temperature for more consistent performance.	23.4	1999 & 2003	X	X		X
Electrical	Generators	Generator Instrumentation	Generator and equipment life increased because user can monitor power output.	23.4.6	1996	X	X		
Electrical	Generators	PTO and Hydraulic Generator Interlocks and Indicators	Generator and equipment life increased because interlocks ensure generator output is correct Improved safety through consistent used of indicators and interlocks. Improved safety because interlocks prevent unexpected or improper operation. Hydraulic generators must operate at all engine speeds or have speed control systems.	23.5, 23.6.1, 23.6.2	1991	X			X

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Category	Feature	Feature Change	Benefit	NFPA 1901 2009 Edition Requirement	Approximate Year Introduced	Safety	Service	Durability	Performance
Electrical	Generators	Inverter Requirements	Power will be available for equipment because inverters can not be load managed and must operate for two hours minimum.	23.6.5	2003	X			X
Electrical	Lights, Scene	Scene Light Standards	Scene lighting increased for improved firefighter safety.	13.10	1996	X			X
Electrical	Lights, Warning	Optical Warning Light Standards	Warning light visibility improved to 360 degrees around vehicle.	13.8	1996	X			X
Electrical	Lights, Warning	LED Lighting	Visibility increased. Power requirements reduced. Replacement interval reduced.		1999	X		X	X
Electrical	Lights, Work	Control, Indicator, and Work Area Lighting	Night visibility improved. Work area lighting provided.	13.10	1996	X			X
Electrical	Line Voltage	GFCI Receptacles	GFCI protected circuit requirements and information when choosing whether or not to specify GFCI outlets.	22.3.3.1, 22.3.3.2 A.22.3.3	2009	X			X
Electrical	Line Voltage	Transfer Switch Neutral Conductor	Removes a potential path for back feed and meets the requirements of National Electric Code.	22.7.2.3	2009	X	X		X
Electrical	Line Voltage	Load Balancing	Balancing the fixed and variable 120V loads between the legs of the power source during design increases the likelihood that the loads will be balanced in the field. Balanced loads are more likely to utilize the full capacity of the power source.	22.9.3.4	2009	X	X		X
Electrical	Line Voltage	Cord Reel Conductor Size	Reduces the possibility of a load not operating properly due to low voltage.	22.12.5, A22.12.5	2009	X		X	X
Electrical	Line Voltage	Line Voltage Testing	Added testing to verify equipment enclosure grounding.	22.15.4	2009	X	X		X
Electrical	Line Voltage	Line Voltage Testing	Added testing for proper operation of transfer switches.	22.15.5	2009	X	X		X
Electrical	Line Voltage	Line Voltage Standards	Installation methods specified for generators and wiring. National Electrical Code (NEC) requirements specified for improved safety and quality. Frequency and voltage ranges specified for consistent power quality.	Chapter 23	1996	X	X	X	X
Electrical	Line Voltage	Line Voltage Testing	Test criteria established for wiring, power supplies, and equipment. Equipment tested as installed to validate installation and improve reliability. Power supplies tested for two hours with the fire pump operating to validate operation as used.	23.16	1996	X		X	X
Electrical	Line Voltage	Cord Reel Distribution Box	Receptacles not mounted on a horizontal surface and at least 2" from ground. Power on indicator light visible for 360 degrees. Circuit protection sized for the box receptacles.	23.13.8	1996	X		X	X
Electrical	Line Voltage	Equipment Ratings by Location	Equipment must be rated for it's use and location (power ratings, wet/dry environments).	23.2.6	1996	X		X	X
Electrical	Low Voltage Power	Alternator Minimum Idle Capacity	Electrical system capacity at idle ensured.	13.3	1996	X	X	X	X
Electrical	Low Voltage Power	Electrical Load Management	Electrical system overload prevented. Battery condition preserved. Maintenance frequency reduced. Diagnostic capability and serviceability improved. Electrical system failure frequency reduced.	13.3.6	1996	X	X	X	X
Electrical	Wiring	Function Coding of Chassis Wiring	Diagnostics and serviceability improved.	13.2.6	1996		X		
Electrical	Wiring	Wiring Methods and Techniques Weather-Proof Connections	Failure rates reduced. Serviceability improved.	13.2	1996	X	X	X	X
General	Composite Materials	Plastic, Polypropylene, and Composite Components	Lighter weight. Durability improvement. Maintenance improvement. Corrosion resistance.		1991	X	X	X	X
General	Conspicuity	Reflective Striping	Visibility of vehicle increased. Risk of crash reduced.	15.9.2	1991	X			
General	Equipment Mounting	Interior Equipment Mounting and Storage	Interior equipment mounting criteria. Interior storage compartment performance criteria. Crew safety improved during crash.	14.1.10 14.1.11	1996	X		X	X
General	Handrails	Handrail Grip Material	Grip material specified for handrails.	15.8	1996	X			X
General	Paint	Paint Process System Improvement	Harder finish. U.V. protection improvements. Adhesion qualities improved.	15.9	1991			X	
General	Stepping and Walking Surfaces	Slip Resistance Criteria	Interior slip resistance criteria established. Exterior slip resistance criteria established. Testing of surfaces mandated. Documentation of slip resistance mandated.	15.7.3	1999	X			X
General	Steps	Folding Step Standards	Performance standards established. Safety and ergonomics improved.	20.2.9.1	1999	X			
General	Steps	Step Performance Criteria	Step height criteria established. Step size criteria established. Minimum load capacity.	15.7	1991	X			
General	Warning Labels	Warning Labels Specified	Safety improvement through increased identification of hazard areas.	14.1.2 20.23 21.9 22.8 23.13.7 25.2.11	1996	X			
Pump	Foam	Class A Foam Systems	Superior fire knockdown over plain water (2 to 3 times faster). Reduced water consumption and damage. Faster cleanup. Rekindle risk reduced. Environmental damage reduced. Faster recovery of visibility.	Chapter 21	1991	X	X	X	X

FIRE APPARATUS IMPROVEMENT WHITE PAPER

Category	Feature	Feature Change	Benefit	NFPA 1901 2009 Edition Requirement	Approximate Year Introduced	Safety	Service	Durability	Performance
Pump	Foam	Compress Air Foam Systems (CAFS)	Superior fire knockdown over plain water (3 to 5 times faster). Reduced water consumption and damage. Faster cleanup. Rekindle risk reduced. Environmental damage reduced. Faster recovery of visibility. Firefighter fatigue reduced. Exposure protection enhanced.	Chapter 22	1991	X			X
Pump	Foam	Foam Agents & Additives	Improved chemical properties. More efficient heat absorption. Overall reduction in proportioning rates. Longer shelf life. No environmental damage. Reduced maintenance.		1991	X	X	X	X
Pump	Foam	Foam Proportioning System Enhancements	Accuracy and performance improved. Broader operating range. Easier to use. Reliability improved.	Chapter 21	1996	X	X	X	X
Pump	Foam	Foam System Testing	Improved safety and accuracy.	Chapter 21	1999	X			X
Pump	Foam	In-Tank Foam Cells	Reduced firefighter fatigue. Maximize space requirements in hose bed and compartments. Improved accessibility for plumbing to pump and proportioning equipment.	Chapter 21	1991	X			X
Pump	Plumbing	Intake Bleeder Valve Location	Improved operator safety. Pump component protection.	16.6.5.2		X			
Pump	Plumbing	Remote Electrically Actuated Valves	Remote pump panel possible. Smaller more efficient pump panels. Controlled operation.		1991				X
Pump	Plumbing	Flanged Pump Connections	Improved safety. Serviceability improved. Pipe thread connection eliminated. Extended system life.		1991	X	X	X	
Pump	Plumbing	Flexible Hose Used in Pump Compartment	Improved water flow efficiency by eliminating plumbing elbows. Plumbing flexibility improved.		1991		X	X	X
Pump	Plumbing	Inlets and Outlets Increased	Higher pump flow rates possible.	16.7.1	1991				X
Pump	Plumbing	Slow Close Valves	Pressure spikes avoided. Improved operator safety. Stress on plumbing components reduced.	16.7.5	1991	X			X
Pump	Plumbing	Stainless Steel Plumbing	Corrosion resistant. Increased life of plumbing system. Maintenance requirements reduced.		1996			X	
Pump	Plumbing	Thermal Relief Valve	Improved safety. Pump component protection. Enhanced engine cooling.		1991	X			X
Pump	Pressure & Flow Indicators	Digital Flow Indication Devices	Accuracy improved. Easier to read.		1991	X			X
Pump	Pressure Indicators	Intake and Discharge Gauge Accuracy Test	Improved safety & accuracy .	16.13.10		X	X		
Pump	Pressure Indicators	Analog Vaccum Gauges with Larger graduations & displays	Improved accuracy. Easier to use during drafting operations.	16.12.2.1.5.2	2006				X
Pump	Primer	Oil-Less or Biodegradable Pump Primer	Meets EPA requirements. Environmentally safe.	16.10.14	1996	X	X		X
Pump	Pump	Industrial Fire Pumps Curves for Pumps over 3000gpm	Provides defined performance criteria for larger flow pumps	Chapter 16					X
Pump	Pump	Improved Transmission PTO Designs	Allows flexible body designs. Pump and roll options. Ability to PTO drive larger pumps.		1996				X
Pump	Pump	Pump Service Access	Minimum pump access established. Improved serviceability. Less downtime.	15.6	1996		X		
Pump	Pump	Pump Transmissions Improved	Accommodates torque from higher performance engines. Handles torque reversals from transmission mounted retarders.		1994			X	X
Pump	Pump Controls	Enclosed Top-Mount Pump Panel	Safety of operator away from traffic. Safety of operator away from hose. Visibility for pump operator improved. Service access to pump and plumbing improved. Crew comfort improved. Crew communication improved.		1994	X			X
Pump	Pump Controls	User-Friendly Pump Panels	Simplified operation. Operator efficiency. Training time reduced. Crew safety improved.	16.12	1996	X	X		X
Pump	Pump Controls	Pressure Governor	Pressure control improved. Water stream protected from variation.		1991	X			X
Pump	Pump Controls	Pump Engage Inter-locks	Multiple indicators to verify pump engagement. Pump panel throttle lockout. Ability to preset pressure. Improved safety.	16.10	1996	X			X
Pump	Pump Controls	Rear Mount Pump Panel	Safety of operator away from traffic. Service access to pump and plumbing improved.		1999				
Pump	Pump Controls	Top-Mount Pump Panel	Safety of operator away from traffic. Safety of operator away from hose. Visibility for pump operator improved Service access to pump and plumbing improved.		1991	X	X		X
Pump	Safety Interlocks	Pump Interlock	Interlocks to ensure that pump is engaged. Safety Ensured	16.10	1996		X		
Pump	Testing	Hydrostatic Testing Requirements	Plumbing system integrity verified. Safety factors increased.	16.13.8	1991	X		X	
Pump	Water Tank	Spill Proof Tank Overflows/Vents	Improved safety preventing water spillage onto the highways	A.18.4.2.2	2007	X			
Pump	Water Tank	Dump Chutes	Chutes required on rear and both sides of apparatus. Safety improved by providing more flexibility to operator. Speed of operations improved during water shuttle operations.	19.5.2.1	1996	X			X
Pump	Water Tank	Polypropylene Water and Foam Tanks	Lighter weight. Longer lasting. Maintenance requirements reduced. Corrosion resistant.		1991	X	X	X	X