City of Milwaukee
Fire Department

Mark Rohlfing
Chief

Gerard Washington
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April 25, 2012

To the Honorable
Mayor Tom Barrett
Mayor of Milwaukee
200 East Wells Street, Room 201
Milwaukee, WI 53202

Members of the Common Council
200 East Wells Street, Room 205
Milwaukee, WI 53202

RE: Pickup Truck with Ultra-High Pressure Water Systems for Emergency Response (Resolution #110959)

Dear Mayor Barrett and Members of the Common Council,

This letter reflects my research into the viable benefit and use of pickup trucks equipped with an ultra-high pressure water system for use in the City of Milwaukee by the Milwaukee Fire Department.

ULTRA-HIGH PRESSURE WATER SYSTEM

Resolution #110959 questions if the Milwaukee Fire Department (MFD) may be able to increase the efficiency of fire suppression systems, as well as EMS response and transportation, by using an ultra-high pressure (UHP) firefighting system mounted to a pickup truck.

Pickup trucks and other small service vehicles are not used widely in the American Fire Service. Where they are used, they are used in specific roles such as:

- Specialty apparatus that augment a department's response capability.
- Supplements to their full-size apparatus, for very specific uses such as wildland firefighting.
- Response vehicles to some types of EMS calls.

They do not replace traditional apparatus; they are used as additional resources.

Resolution #110959 states that the ultra-high pressure firefighting systems are used by other fire departments as an alternative to engine and ladder trucks when fighting all fires other than internal structure fires. I have found no information that would agree with the above statement; although I have found some fire departments that are using small vehicles with water systems. These vehicles are not used as replacements for full-size engine or ladder trucks. I have found no departments that are using an ultra-high pressure system mounted on a small vehicle as a replacement for Class 1 engines.

The HMA Fire ultra-high pressure fire suppression system is essentially a high pressure pump and motor attached to a water tank with a hose on a reel with an adjustable nozzle. A combination of the nozzle and the high pressure breaks up the water droplets to about one-tenth their normal size. The effect is that less water will cover a larger total surface area. The nozzle delivers 20 or 30 gallons per minute (depending on the system and nozzle that is purchased). The system is built on a skid and can be mounted on the bed of a standard ¾- or 1-ton pickup truck, an all terrain vehicle, or a standard fire truck (with modifications).

While the system has merit it is not a "new concept" as marketed by HMA Fire. The concept of using high pressure and high intensity fog nozzles under pressure has been around the fire service for many years.

Many departments including Milwaukee used booster lines (a smaller diameter hose line) on their Class 1 engines as a means to allow firefighters to apply small amounts of water with fog nozzles to small exterior fires. These smaller hose lines have been removed from most Class 1 engines used in urban environments because of safety concerns. These small diameter lines are still available on all NFPA Class 3 (wildland / brush firefighting apparatus) and Class 6 (compressed air foam) type engines. Class 3 and Class 6 type engines are designed to fight exterior fires such as wildland fires, grass and brush fires, and small exterior off-road fires and are used almost exclusively in the wildland arena.

The ultra-high pressure fire suppression system that is used by the Middleton (Wisconsin) Fire Department that was demonstrated at MATC, and I reviewed, is manufactured by HMA Fire in Madison Wisconsin. It is marketed as an "attack system for fuel, forest, wildland, grass, and vehicle or structure fires." The system when mounted to a small vehicle is limited to a 100-gallon water tank.

After reviewing the system I agree that the system is capable of being used in all the above mentioned applications, within the limitations of the system's water supply and only for small exterior structure fires. The HMA system when attached to a vehicle that is capable of leaving hard surface roads in an environment without adequate water could be a very valuable tool in handling wildland fires, grass fires, and fuel fires.

The Middleton Fire Department currently uses an HMA ultra-high pressure fire suppression system. The system is carried on a command vehicle; a one-ton pickup truck. The

Middleton Fire Department protects a population of approximately 30,000 and covers 54 square miles; it is located on the western edge of Madison. Middleton is a small combination department; they have volunteer firefighters (paid on-call) with four full-time paid command officers.

I spoke with Assistant Chief Gary Gillitzer during my visit to Middleton. Chief Gillitzer was very clear about how the department uses their UHP system from HMA. When they receive a fire call, the full-time paid command officer responds to the fire call (a volunteer firefighter will also respond if one is available) with the command vehicle carrying the HMA ultra-high pressure fire suppression system. If the command officer can use the system to keep a fire in check or to begin putting out a dumpster fire, car fire, or small exterior fire, they will immediately engage it. They use the HMA system to try to reduce the effects of the fire while their volunteer firefighters are responding, first responding to the station, and then to the fire call in their Class 1 engine. They do not use the system for interior attack; however, they will at times use the UHP system at a structure fire but always in conjunction with a hand-line off of a Class 1 engine. They rely on their Class 1 engine, the tools, and firefighters it carries to respond and mitigate their fire calls. They also use the UHP system for fighting brush, grass, and wildland fires.

The Middleton Fire Department responds to two or three "working building fires" per year. Middleton currently is building a rescue apparatus that will have an HMA system fit onto this full-size apparatus; they see the HMS ultra-high pressure system as "another tool" on their new rescue truck.

After review of the ultra-high pressure fire suppression system as demonstrated by HMA Fire, I have concluded that the purchase of the ultra-high pressure fire suppression system by the Milwaukee Fire Department would not be a wise use of taxpayers' dollars. The HMA ultra-high pressure fire suppression system does not add any "new" ability to our department's firefighting assets. The Class 1 engines we use every day are able to handle all our fire and rescue responses which make up only 16% of our call volume. We do not respond to wildland fires and our incidents of fuel fires and grass fires are very low. We do not need to duplicate our capacity by adding ultra-high pressure systems.

The Milwaukee Fire Department's decision not to purchase the ultra-high pressure fire suppression system is based on the following reasons.

1. **SAFETY.** We need an adequate amount of water applied appropriately to the fire to keep our firefighters safe.
   Safe, effective, and efficient fire control requires:
   - Sufficient water to control the fire environment as well as direct attack on the fire. Our interior-reduced attack lines supply anywhere from 180 to 200 gallons per minute (UHP 20-30 gallons/minute).

- An appropriate flow-rate for the correct tactical application (cooling hot, but unignited gases may be accomplished by using an indirect fire attack at a lower flow rate than a direct attack* on the fire).
- A direct attack to exceed the critical flow** based on the fire's heat releases.
- A sufficient reserve (flow rate) must be available to control potential increases in the heat release rate that may result from changes in ventilation.
- Water application in a form appropriate to cool its intended target. (This could mean a direct attack or small droplets [fog] to cool hot gases or to cover hot surfaces with a thin film of water [indirect attack].)
- Water to reach its intended target. (Fog stream to place water into the hot gas layer and a straight or solid stream to pass through hot gases and flames and reach the fire or hot surfaces.)
- Control of the fire without excessive use of water.

*Direct attack usually indicates using a straight stream pattern to put water on the seat of the fire.
**Critical flow is the water flow necessary to control and extinguish the fire.

While the ultra-high pressure fire suppression system provides an alternate means of putting water on a fire, it does not provide the necessary capabilities that we need to safely, effectively and efficiently, control and extinguish every fire.

2. **CURRENT RESOURCES.** The Milwaukee Fire Department has thirty–six (36) Class 1 engines that meet all the appropriate National Fire Protection Association (NFPA) 1901 standards. These engines provide all the capabilities we need to safely, effectively, and efficiently extinguish the fires we respond to in our urban environment.

   The ultra-high pressure system feature of breaking down the water droplets into very small particles is a benefit and does allow for very efficient steam conversion. This higher efficiency steam conversion does use less water and HMA markets the system as a low-water-use system. The same steam conversion principal is employed when we use our standard fog setting on our 1-3/4" reduced attack lines. Although the HMA UHP system uses less water to convert heat to steam, the amount of water actually used to extinguish a fire is dependent on the size and extension of the fire, and the firefighter who is operating the nozzle.

3. **NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS.** The HMA ultra-high pressure fire suppression system does not meet the NPFA standards for interior firefighting. As per HMA they are working through the NFPA certification process; hoping to receive certification. The certification process is slow and difficult; the time frame stated by HMA representatives is at least five (5) years. The small engine that drives the water pump also does not meet NFPA standards (NFPA 1901 Chapter 16, Fire Pumps and Associated Equipment - see attached); it

is not considered reliable enough for the system to be used for interior firefighting. We must have a reliable water supply whenever our firefighters attack a fire, either when they enter a burning structure or when we are facing exterior fire conditions.

Further, the ultra-high pressure fire suppression system mounted on pickup trucks does not meet NFPA standards (NFPA 1901 Chapter 6, Initial Attack Fire Apparatus Standards - see attached).

4. **COST.** The cost of the system, $20,000 for the HMA ultra-high pressure fire suppression system skid, and $40,000-$45,000 for the trucks to carry the system, adds a very expensive piece of equipment to our apparatus fleet that has a very limited capability. We would be spending tax dollars to duplicate our current fire extinguishment capacity. The pickup truck with the HMA UHP skid also leaves very little room for additional equipment.

5. **INNOVATIONS.** New ideas and innovations must meet the needs of the department. The ultra-high pressure fire suppression system would seem to be innovative and offer the fire service a "new" approach to a very old fire extinguishment problem. In some applications it may be more efficient; however, it does not add a "new" approach that can effectively be used by the MFD in the urban environment that we serve. The Milwaukee Fire Department is always looking for new and innovative equipment and/or techniques to make our job safer and to provide a better service to the citizens of Milwaukee. This system and delivery method does not offer that innovation.

SMALL RESPONSE VEHICLES / PICKUP TRUCKS

The Milwaukee Fire Department has made the decision not to pursue the purchase of the ultra-high pressure fire suppression system mounted on pickup trucks, but is actively continuing to study the use of pickup trucks for emergency medical services (EMS) responses. Before making the decision to use smaller vehicles to respond to EMS calls we need to make sure that we are satisfied that safety and response times will not be compromised and that spending capital dollars for smaller vehicles makes fiscal sense. The following concerns are being further studied.

1. **SAFETY.** The safety of the men and women of the Milwaukee Fire Department is my greatest concern. To routinely respond in a pickup truck with only EMS capacity could put both our firefighters and the citizens of Milwaukee at risk. We are currently reviewing the risks of responding to EMS calls in a pickup; the increased risk comes from being in the pickup truck returning from an EMS call and being dispatched to a fire/rescue call. Our challenge/task is to see if we can find locations in the city that would work for the small truck response that does not significantly increase the risk to our firefighters and citizens.

Fire departments respond with Class 1 engines and ladder trucks because they have been designed with fire and rescue emergencies in mind. They are equipped with the necessary equipment required to handle all the emergencies routinely responded to in order to effect positive outcomes. Each time we leave our station we must be as prepared as possible to handle the emergency we may be dispatched on. Even though only 1% of our calls are structure fires, those fire calls represent our most serious and critical calls. They are low-probability high-danger calls. We are looking at the statistics to make sure that if we choose to use smaller vehicles that we do the best job we can to mitigate the risk of having our firefighters in service in the wrong apparatus. I want to minimize the chance of a Milwaukee fire company being without the proper apparatus or equipment when called to a fire emergency. It is imperative that solid response data drive our decision. If we decide to use small trucks for EMS responses we need to make sure we assign them in the appropriate stations.

The need for quick response times and immediate action at fire scenes is more important today than it has ever been. Today we are faced with fires that grow and spread very quickly. Because of large increases of synthetic materials in modern homes and businesses, including foams, plastics, vinyl, and volatile coatings, we are now experiencing fires with higher rates of heat-release than ever before. These fires are also spreading faster than ever before.

The benchmark for the American Fire Service when attacking interior fires is to attack the fire before flashover occurs. If we can aggressively extinguish or control the fire before flashover we have a good chance of saving lives and minimizing property damage. When home furnishings and floor coverings consisted of mainly natural materials, upon arrival at a fire scene we had enough time (29 minutes 30 seconds*) before flashover to make an effective fire attack and do our rescue work. Today, we are lucky to get to the scene moments before flashover. In a modern home flashover can occur as early as 3 minutes and 30 seconds* into the fire. Historically under the best conditions we make our interior attack at the 8- to 9-minute mark in the fire. This fast-fire spread combined with modern construction techniques make a home unsafe to enter at times within 5 to 10 minutes of fire growth. These conditions put the public and our firefighters at great risk very early into the fire and necessitate good response times and immediate action once we arrive at the scene. In these critical situations we do not have the luxury to be in a pickup truck without the needed equipment, tools, and means to quickly respond and aggressively attack a structure fire. Although 1% of our calls are working fires, approximately 16% of our calls are fire and rescue calls in which the equipment and tools we carry on our Class 1 engines and trucks are needed. We should not use alternative vehicles when we respond to our fire and rescue calls.

*Underwriters Laboratory experiment, the Comparison of Modern and Legacy Home Furnishings under fire conditions.

2. **EFFICIENCY and EFFECTIVENESS.** For the Milwaukee Fire Department to be efficient and effective when responding to fire and EMS calls we need to make sure:
    - We respond to our calls for service within the National Standards, as defined in NFPA 1710.
    - The response apparatus we respond with has the tools and equipment necessary to mitigate the emergency.

3. **EFFECTIVE EMS.** For the pickups to be effective response units for EMS responses they need additional fire and rescue equipment tools and a full complement of BLS supplies and equipment.

4. **ENSURE EFFECTIVENESS OF CHANGE.** Change and innovation are encouraged and highly desirable, but that change and innovation must work for the department. The Milwaukee Fire Department is actively gathering the data to see if the placement of pickup trucks appropriately located for EMS responses would increase our efficiency while not significantly increasing our risk. We also must make sure that there is enough financial savings to move forward with a small-vehicle placement plan. This change must be a wise monetary investment for the City.

Sincerely,

Mark Rohlfing

MARK ROHLFING
Chief

MR/cf

Mayor\High Pressure Water System (Resolution #110959)
Attachment
cc: Mike Tobin/F&P
Patrick Curley/Mayor
Jodie Tabak/Mayor

City of Milwaukee

Martin Matson
Comptroller

John M. Egan, C.P.A.
Special Deputy Comptroller

Office of the Comptroller

April 24. 2012

The Honorable Tom Barrett, Mayor
The Honorable, the Common Council
City of Milwaukee
City Hall, 200 E. Wells St.
Milwaukee, WI 53202

Resolution # 110959 – Study of Fire Suppression and Transportation in the Milwaukee Fire Department

Mayor Barrett and Members of the Common Council:

Resolution 110959 directs the Fire Department and the City Comptroller's Office "...to conduct a study relating to increasing the efficiency of fire suppression systems and transportation of the Fire Department;". The materials accompanying this letter comprise our Departments' collective response to this Resolution.

Enclosed is a letter from Chief Rohlfing dated April 24, 2012 addressing two major issues surrounding the above Resolution:
1) use of an ultra-high pressure water system for fire suppression; and
2) addition of small response vehicles (pick-up trucks) to the Department's vehicle fleet.

Regarding issue #1), the Fire Department concludes that "...the purchase of the ultra-high pressure fire suppression system by the Milwaukee Fire Department would not be a wise use of taxpayers' dollars.". The Department's support for this conclusion is detailed in the letter. Regarding issue #2) the Department indicates that it "...is actively continuing to study the use of pickup trucks for emergency medical services (EMS) responses.". Chief Rohlfing adds that the "...Department is actively gathering the data to see if the placement of pickup trucks appropriately located for EMS responses would increase our efficiency while not significantly increasing our risk.".

The Comptroller's Office is unable to comment on the effectiveness of applying ultra-high pressure fire suppression systems in the Milwaukee Fire Department as such matters are beyond the scope of the Comptroller's Office authority and expertise. Regarding the potential use of appropriately equipped pickup trucks to respond to EMS calls for service, we conclude that the potential for significant savings in the operation and use of Department vehicles does exist if certain important operational questions/issues can be addressed. These operational issues are discussed in detail in Chief Rohlfing's letter.

The conclusion supporting the potential savings from the use of pickup trucks for EMS responses is documented in a series of spreadsheets also enclosed with this letter. These spreadsheets use actual

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2010 data and apply key operating and cost assumptions developed by and in conjunction with the Fire Department. See page 1 of the enclosed spreadsheet. These actual data and assumptions were then applied consistently to derive an estimate of 2010 MFD fleet costs under three differing scenarios:

SCENARIO*	**2010 MFD VEHICLE RELATED COSTS***
Scenario A) (Spreadsheet pg 2) **The existing MFD vehicle fleet** (no change from current)	**$3,186,000**
Scenario B) (Spreadsheet pg 3) **The addition of 6 pickup trucks** to the existing vehicle fleet with the pickup trucks handling 20% of the 2010 EMS calls for service taken by the ladder Trucks and Engine Companies. (Cost to purchase & equip 6 pick-up trucks = $ 408,000)	**$2,745,000**
Scenario C) (Spreadsheet pg 4) **The addition of 30 pickup trucks** to the existing vehicle fleet with the pickup trucks handling 100% of the 2010 EMS calls for service taken by the ladder Trucks and Engine Companies. (Cost to purchase & equip 30 pick-up trucks = $2,040,000)	**$1,461,000**

*Excludes medical and battalion units and their related costs and calls for service.

MFD staffing is assumed to be unchanged in all scenarios. The addition of pickup trucks to the MFD vehicle fleet results in annual savings due to two principle factors. The primary savings derives from the extended useful lives (and later replacement) of ladder trucks and engine company vehicles as all or a portion of EMS calls for service are responded to by the pickup trucks instead of these larger vehicles. The second source of savings is lower fuel costs.

NOTE: The above are very approximate estimates to be used only for initial comparison purposes. These are not numbers ready for budgeting. As mentioned earlier, the effective use of any pickup trucks is dependent on the resolution of operational issues identified in Chief Rohlfing's letter and page 5 of the excel spreadsheet analysis. Also, a more detailed costing and analysis of the planned placement of newly purchased pickup trucks would be required for budget decision-making purposes.

Should you have any questions or comments, please contact Chief Rohlfing or myself at your convenience.

Sincerely,

Martin Matson

Martin Matson
Comptroller

Cc. Michael Tobin, Mark Nicolini, Patrick Curley

Data and Assumptions of the Milwaukee Fire Department
if small pickup trucks were introduced in the MFD

1) In the event that UHP units were purchased and installed on new acquired small (pick up) trucks,
there would be no replacement or substitution of Class 1 engines or ladder trucks.

2) The small vehicles (pickup trucks) equipped with UHP units would not be used by the MFD as initial attack fire vehicle for any type of fire.

3) The small vehicles would respond only to EMS calls now handled by the Class 1 engines and ladder trucks.
These small vehicles would need to be equipped with appropriate equipment.

4) Purchase price of Class 1 Engine = $500,000; Ladder Truck = $725,000; 1 ton 4 passenger pickup truck = $45,000 for truck
(additional $20,000 for UHP fire fighting equipment and / or $23,000 for EMS equipment and $10,000 for additional eqiupment).

5) Useful life of new vehicles: 110,000 miles for Class 1 engines; 80,000 miles for ladder trucks; 125,000 miles for pickup trucks.

6) Class 1 engines and ladder trucks continue to respond to all fire, rescue and service calls as is currently performed.
Pickup trucks respond only to the EMS calls now handled by Class 1 engines and ladder trucks.

7) 2011 data: 3,696 fire calls, 8,184 rescue calls and 1,260 service calls; 56,085 EMS calls (26,125 ALS and 29,960 BLS)

8) Average one way miles per call (all call types) = 3 miles.

9) Miles per gallon: 4.19 miles per gallon for Class 1 engines and 2.65 miles per gallon for ladder trucks; 12 miles per gallon for small pickups.

10) Routine maintenance: $1,000 per year for Class 1 engines and ladder trucks.

11) Average annual repair costs: Class 1 engines and ladder trucks = $7,000 per year

12) "Occasional" major repair: Class 1 engines and ladder trucks: - $6,000 once every three years or $2,000/yr.

13) Battalion Chiefs and Med unit trips unaffected by the introduction of pickup trucks.

14) # of ladder truck companies (15); # of engine companies (36).with 3 brown-outs per day Source - MFD 2010 Annual Report, pg. 18.

15) Current cost of fuel: $3.06 per gallon for diesel fuel (used by Class 1 engines and ladder trucks); $2.83 per gallon
non leaded gasoline used by pickup trucks.

16) Estimated routine maintenance cost for pickup trucks = $750 per year.

17) Average annual repair costs: pickup trucks = $1,500 per year

18) Estimated "occasional" major repair: pickup truck - $2,250 every three years or $750/yr.

19) Ladder trucks and engine companies handle the same share of fire, rescue and service (non-EMS) calls as each did in 2011.

20) With pickups, same Department staffing at same station locations as without pickups (staff responding to EMS vs Fire calls interchangeable).

Mjd/4-19-12

		Scenario A) Current System without Small Pickup Vehicles					
Average miles per call =		Gas Cost per gal =		$ 2.83	Feb. 2012		
(one way)	3	Diesel cost per gal =		$ 3.06	Feb. 2012		
Ladder Trucks:				Engine Companies			Pick up w/system
useful life =	80,000			110,000			125,000
(miles)							
Purchase Price =	$ 725,000			$ 500,000			$ 68,000
Preventative Maint./yr =	$ 1,000			$ 1,000			$ 750
Repairs (normal)/yr	$ 7,000			$ 7,000			$ 1,500
Repairs (occasional)/yr.	$ 2,000			$ 2,000			$ 750
Miles per gallon =	2.65			4.19			12
Number of Vehicles	15			36	with 3 brown-outs per day		0
			("Wearing out")				
			Depreciation	Maint+Repair/	Annual gasoline	Total Cost/	Total Cost
	# Trips/yr.	#Trips per vehicle/yr	per vehicle/yr	vehicle/yr	Cost per vehicle/yr	vehicle/yr	all vehicles
Ladder Companies							
Ladder Truck	16,337	1,089	$ 59,222	$ 10,000	$ 7,546	$ 76,768	$ 1,151,518
Engine Companies							
Engine Class 1	52,888	1,469	$ 40,067	$ 10,000	$ 6,437	$ 56,504	$ 2,034,145
Pick up Trucks	0						0
TOTAL	69,225				Total cost/yr excluding		
					medical units & battalion units =		$ 3,185,663
Mjd/4-19-12							

Pg 3-With 6 Pickups

		Scenario B) Current System with 6 Small Pickup Vehicles					
Average miles per call =		Gas Cost per gal =		$ 2.83	Feb. 2012		
(one way)	3	Diesel cost per gal =		$ 3.06	Feb. 2012		
Ladder Trucks:				**Engine Companies**			**Pickup w/System**
useful life =	80,000			110,000			125,000
(miles)							
Purchase Price =	$ 725,000			$ 500,000			$ 68,000
Preventative Maint./yr =	$ 1,000			$ 1,000			$ 750
Repairs (normal)/yr	$ 7,000			$ 7,000			$ 1,500
Repairs (occasional)/yr.	$ 2,000			$ 2,000			$ 750
Miles per gallon =	$ 2.65			$ 4.19			$ 12.00
Number of Vehicles	15			36	with 3 brown-outs per day		6
			("Wearing out")				
			Depreciation	Maint+Repair/	Annual gasoline	Total Cost/	Total Cost
	# Trips/yr.	#Trips per vehicle/yr	per vehicle/yr	vehicle/yr	Cost per vehicle/y	vehicle/yr	all vehicles
Ladder Companies							
Ladder Truck	11,064	738	$ 40,106	$ 10,000	$ 5,110	$ 55,216	$ 828,241
Engine Companies							
Engine Class 1	46,941	1,304	$ 35,562	$ 10,000	$ 5,714	$ 51,275	$ 1,845,908
Pick up Trucks*	11,220	1,870	$ 6,104	$ 3,000	$ 2,646	$ 11,750	$ 70,498
TOTAL	69,225				Total cost/yr excluding		
* 1,870 annual trips with 30 vehicles is about 5 trips per vehicle per day.					medical units & battalion units =		$ 2,744,647
Outlay to purchase							
6	pickup units =	$ 408,000					
Mjd/4-19-12							

Pg 4-With 30 Pickups

Average miles per call =		Gas Cost per gal =		$ 2.83	Feb. 2012		
(one way)	3	Diesel cost per gal =		$ 3.06	Feb. 2012		
Ladder Trucks:				**Engine Companies**			**Pickup w/System**
useful life =	80,000			110,000			125,000
(miles)							
Purchase Price =	$ 725,000			$ 500,000			$ 68,000
Preventative Maint./yr =	$ 1,000			$ 1,000			$ 750
Repairs (normal)/yr	$ 7,000			$ 7,000			$ 1,500
Repairs (occasional)/yr.	$ 2,000			$ 2,000			$ 750
Miles per gallon =	2.65			4.19			12
Number of Vehicles	15			36	with 3 brown-outs per day		30
			("Wearing out") Depreciation per vehicle/yr	Maint+Repair/ vehicle/yr	Annual gasoline Cost per vehicle/yr	Total Cost/ vehicle/yr	Total Cost all vehicles
	# Trips/yr.	#Trips per vehicle/yr					
Ladder Companies							
Ladder Truck	6,176	412	$ 22,387	$ 10,000	$ 2,853	$ 35,240	$ 528,597
Engine Companies							
Engine Class 1	6,964	193	$ 5,276	$ 10,000	$ 848	$ 16,124	$ 580,449
Pick up Trucks*	56,085	1,870	$ 6,102	$ 3,000	$ 2,645	$ 11,747	$ 352,422
TOTAL	69,225				Total cost/yr excluding		
* 1,870 annual trips with 30 vehicles is about 5 trips per vehicle per day.					medical units & battalion units =		$ 1,461,468
Outlay to purchase							
30	pickup units =	$ 2,040,000					
Mjd/4-19-12							

Other factors to be considered in evaluating the potential use of pickup vehicles.
How many pick-up trucks can be placed in service to keep the risk level manageable if 2 or more where out of quarters with there Class 1 apparatus.
How many and which fire stations can accomadate a pick-up truck next to the current fire apparatus.
What basic equipment needs to be placed on the pick-up trucks, along with a full complement of BLS supplies and equipment.
Do the pick-up trucks need SCBA's
What is the cost of upgrading the chosen stations with Plymo-Vent exhaust extraction equipment
What will the mechanical downtime be for the smaller gas or diesel pick-up trucks
MFD 4/18/12

Chapter 6 Initial Attack Fire Apparatus

6.1 General. If the apparatus is to function as an initial attack fire apparatus, it shall meet the requirements of this chapter.

6.2 Fire Pump. The apparatus shall be equipped with a fire pump that meets the requirements of Chapter 16 and that has a minimum rated capacity of 250 gpm (1000 L/min).

6.3 Water Tank. Initial attack apparatus shall be equipped with a water tank(s) that meets the requirements of Chapter 18 and that has a minimum certified capacity (combined, if applicable) of 200 gal (750 L).

6.4* Equipment Storage. A minimum of 22 ft^3 (0.62 m^3) of enclosed weather-resistant compartmentation that meets the requirements of Section 15.1 shall be provided for the storage of equipment.

6.5* Hose Storage. Hose bed area(s), compartments, or reels that meet the requirements of Section 15.10 shall be provided to accommodate the following:

(1) A minimum hose storage area of 10 ft^3 (0.3 m^3) for 2½ in. (65 mm) or larger fire hose
(2) Two areas, each a minimum of 3.5 ft^3 (0.1 m^3), to accommodate 1½ in. (38 mm) or larger preconnected fire hose lines

6.6* Equipment Supplied by the Contractor. The contractor shall supply the equipment listed in 6.6.1 and 6.6.2 and shall provide and install such brackets or compartments as are necessary to mount the equipment.

6.6.1 Ground Ladders.

6.6.1.1 A 12 ft (3.7 m) or longer combination or extension-type fire department ground ladder shall be carried on the apparatus.

6.6.1.2 All fire department ground ladders on the apparatus shall meet the requirements of NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, except as permitted by 6.6.1.3.

6.6.1.3 Stepladders and other types of multipurpose ladders shall be permitted to be carried in addition to the minimum fire department ground ladders specified in 6.6.1.1 provided they meet either ANSI A14.2 or ANSI A14.5 with duty ratings of Type 1A or 1AA.

6.6.2 Suction Hose or Supply Hose.

6.6.2.1 A minimum of 20 ft (6 m) of suction hose or 15 ft (4.5 m) of supply hose shall be carried.

6.6.2.1.1 Where suction hose is provided, a suction strainer shall be furnished.

6.6.2.1.2 Where suction hose is provided, the friction and entrance loss of the combination suction hose and strainer shall not exceed the losses listed in Table 16.2.4.1(b) or Table 16.2.4.1(c).

6.6.2.1.3 Where supply hose is provided, it shall have couplings compatible with the local hydrant outlet connection on one end and the pump intake connection on the other end.

6.6.2.2 Suction hose and supply hose shall meet the requirements of NFPA 1961, *Standard on Fire Hose.*

6.6.2.3* The purchaser shall specify whether suction hose or supply hose is to be provided, the length and size of the hose, the type and size of the couplings, the manner in which the hose is to be carried on the apparatus, and the style of brackets desired.

6.7* Minor Equipment.

6.7.1 General. The equipment listed in 6.7.2 and 6.7.3 shall be available on the initial attack fire apparatus before the apparatus is placed in service.

6.7.1.1 Brackets or compartments shall be furnished so as to organize and mount the specified equipment.

6.7.1.2 A detailed list of who is to furnish the items and the method for organizing and mounting these items shall be supplied by the purchasing authority.

6.7.2 Fire Hose and Nozzles. The following fire hose and nozzles shall be carried on the apparatus:

(1) 300 ft (90 m) of 2½ in. (65 mm) or larger fire hose
(2) 400 ft (120 m) of 1½ in. (38 mm), 1¾ in. (45 mm), or 2 in. (52 mm) fire hose
(3) Two handline nozzles, 95 gpm (360 L/min) minimum

6.7.3* Miscellaneous Equipment. The following additional equipment shall be carried on the apparatus:

(1) One 6 lb (2.7 kg) pickhead axe mounted in a bracket fastened to the apparatus
(2) One 6 ft (2 m) pike pole or plaster hook mounted in a bracket fastened to the apparatus
(3) Two portable hand lights mounted in brackets fastened to the apparatus
(4) One approved dry chemical portable fire extinguisher with a minimum 80-B:C rating mounted in a bracket fastened to the apparatus
(5) One 2½ gal (9.5 L) or larger water extinguisher mounted in a bracket fastened to the apparatus
(6) One SCBA complying with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, for each assigned seating position, but not fewer than two, mounted in brackets fastened to the apparatus or stored in containers supplied by the SCBA manufacturer
(7) One spare SCBA cylinder for each SCBA carried, each mounted in a bracket fastened to the apparatus or stored in a specially designed storage space(s)
(8) One first aid kit
(9) Two combination spanner wrenches mounted in a bracket(s) fastened to the apparatus
(10) One hydrant wrench mounted in a bracket fastened to the apparatus
(11) One double female adapter, sized to fit 2½ in. (65 mm) or larger fire hose, mounted in a bracket fastened to the apparatus
(12) One double male adapter, sized to fit 2½ in. (65 mm) or larger fire hose, mounted in a bracket fastened to the apparatus
(13) One rubber mallet, for use on suction hose connections, mounted in a bracket fastened to the apparatus
(14) Two or more wheel chocks, mounted in readily accessible locations, that together will hold the apparatus, when loaded to its GVWR or GCWR, on a hard surface with a 20 percent grade with the transmission in neutral and the parking brake released
(15) One traffic vest for each seating position, each vest to comply with ANSI/ISEA 207, *Standard for High-Visibility Public Safety Vests*, and have a five-point breakaway feature that includes two at the shoulders, two at the sides, and one at the front

(16) Five fluorescent orange traffic cones not less than 28 in. (711 mm) in height, each equipped with a 6 in. (152 mm) retroreflective white band no more than 4 in. (102 mm) from the top of the cone, and an additional 4 in. (102 mm) retroreflective white band 2 in. (51 mm) below the 6 in. (152 mm) band
(17) Five illuminated warning devices such as highway flares, unless the five fluorescent orange traffic cones have illuminating capabilities
(18) One automatic external defibrillator (AED)

6.7.3.1 If none of the pump intakes are valved, a hose appliance that is equipped with one or more gated intakes with female swivel connection(s) compatible with the supply hose used on one side and a swivel connection with pump intake threads on the other side shall be carried. Any intake connection larger than 3 in. (75 mm) shall include a pressure relief device that meets the requirements of 16.6.6.

6.7.3.2 If the apparatus does not have a 2½ in. intake with NH threads, an adapter from 2½ in. NH female to a pump intake shall be carried, mounted in a bracket fastened to the apparatus if not already mounted directly to the intake.

6.7.3.3 If the supply hose carried has other than 2½ in. NH threads, adapters shall be carried to allow feeding the supply hose from a 2½ in. NH thread male discharge and to allow the hose to connect to a 2½ in. NH female intake, mounted in brackets fastened to the apparatus if not already mounted directly to the discharge or intake.

Chapter 7 Mobile Water Supply Fire Apparatus

7.1 General. If the apparatus is to function as a mobile water supply apparatus, it shall meet the requirements of this chapter.

7.2 Pump. If the apparatus is equipped with a fire pump, the pump shall meet the requirements of Chapter 16.

7.3 Water Tank. The mobile water supply apparatus shall be equipped with a water tank(s) that meets the requirements of Chapter 18 and that has a minimum certified capacity (combined, if applicable) of 1000 gal (4000 L).

7.4* Equipment Storage. A minimum of 20 ft^3 (0.57 m^3) of enclosed weather-resistant compartmentation meeting the requirements of Section 15.1 shall be provided for the storage of equipment.

7.5 Hose Storage.

7.5.1* A minimum hose storage area of 6 ft^3 (0.2 m^3) for 2½ in. (65 mm) or larger fire hose that meets the requirements of Section 15.10 shall be provided.

7.5.2 If the apparatus is equipped with a fire pump, two areas, each a minimum of 3.5 ft^3 (0.1 m^3), to accommodate 1½ in. (38 mm) or larger preconnected fire hose lines shall be provided.

7.6* Suction Hose or Supply Hose. If the mobile water supply fire apparatus is equipped with a pump, the requirements in 7.6.1 through 7.6.3 shall apply.

7.6.1 A minimum of 20 ft (6 m) of suction hose or 15 ft (4.5 m) of supply hose shall be carried.

7.6.1.1 Where suction hose is provided, a suction strainer shall be furnished.

7.6.1.2 Where suction hose is provided, the friction and entrance loss of the combination suction hose and strainer shall not exceed the losses listed in Table 16.2.4.1(b) or Table 16.2.4.1(c).

7.6.1.3 Where supply hose is provided, it shall have couplings compatible with the local hydrant outlet connection on one end and the pump intake connection on the other end.

7.6.2 Suction hose and supply hose shall meet the requirements of NFPA 1961, *Standard on Fire Hose.*

7.6.3* The purchaser shall specify whether suction hose or supply hose is to be provided, the length and size of the hose, the type and size of the couplings, the manner in which the hose is to be carried on the apparatus, and the style of brackets desired.

7.7* Minor Equipment.

7.7.1 The equipment listed in 7.7.2 and 7.7.3 shall be available on the initial attack fire apparatus before the apparatus is placed in service.

7.7.1.1 Brackets or compartments shall be furnished so as to organize and mount the specified equipment.

7.7.1.2 A detailed list of who is to furnish the items and the method for organizing and mounting these items shall be supplied by the purchasing authority.

7.7.2 Fire Hose and Nozzles.

7.7.2.1 The mobile water supply apparatus shall be equipped with at least 200 ft (60 m) of 2½ in. (65 mm) or larger fire hose.

7.7.2.2* If the mobile water supply apparatus is equipped with a fire pump, the following shall be provided:

(1) 400 ft (120 m) of 1½ in. (38 mm), 1¾ in. (45 mm), or 2 in. (52 mm) fire hose
(2) Two handline nozzles, 95 gpm (360 L/min) minimum

7.7.3 Equipment.

7.7.3.1* Mobile water supply fire apparatus shall be equipped with at least the following equipment:

(1) One 6 lb (2.7 kg) flathead or pickhead axe mounted in a bracket fastened to the apparatus
(2) One 6 ft (2 m) or longer pike pole or plaster hook mounted in a bracket fastened to the apparatus
(3) Two portable hand lights mounted in brackets fastened to the apparatus
(4) One approved dry chemical portable fire extinguisher with a minimum 80-B:C rating mounted in a bracket fastened to the apparatus
(5) One 2½ gal (9.5 L) or larger water extinguisher mounted in a bracket fastened to the apparatus
(6) One SCBA complying with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services,* for each assigned seating position, but not fewer than two, mounted in brackets fastened to the apparatus or stored in containers supplied by the SCBA manufacturer
(7) One spare SCBA cylinder for each SCBA carried, each mounted in a bracket fastened to the apparatus or stored in a specially designed storage space(s)
(8) One first aid kit
(9) Two combination spanner wrenches mounted in a bracket fastened to the apparatus
(10) One hydrant wrench mounted in a bracket fastened to the apparatus

15.11.2 When mounted on the apparatus, ground ladders shall not be subject to exposure to heat sources (such as engine heat) of 212°F (100°C) or greater. [**1932**:4.1.3]

15.11.3 Ground ladders shall be supported to prevent any sagging or distortion while they are mounted on the fire apparatus. [**1932**:4.1.4]

15.11.4 The rollers and other moving parts of the frame holding the ground ladders on the apparatus shall be readily accessible to permit lubrication.

15.12* Receivers and Anchors for Rope and Removable Winches.

15.12.1 Receivers or anchors installed at any location on the apparatus for use as removable winch anchors shall be designed and affixed to provide at least a 2.0 to 1 straight line pull no-yield safety factor over the load rating of the removable winch.

15.12.2 Receivers or anchors installed at any location on the apparatus for use with rope operations shall be designed and affixed to the apparatus to provide at least a 9000 lbf (40,000 N) no-yield condition with a straight line pull.

15.12.3 A label shall be placed on or near each receiver or anchor that states the maximum straight line pull rating of the anchor.

15.13 Slip-On Fire-Fighting Module. If the pump, piping, and tank are built as a slip-on, self-contained unit, it shall meet the requirements of 15.13.1 through 15.13.3 and shall be mounted on the fire apparatus in accordance with 15.13.4.

15.13.1 The major components of the slip-on module, including the pump, pumping engine, water and agent tank(s), plumbing system, and electrical system shall meet the requirements of the applicable chapters of this standard covering those components.

15.13.2 Intake and discharge piping shall not interfere with the routine maintenance of the pump, engine, or auxiliary systems and shall not unduly restrict the servicing of these components.

15.13.3 The manufacturer of a slip-on fire-fighting module shall provide the following data with the module:

(1) Weight without water but with all other tanks or reservoirs for liquids full
(2) Weight full with water and other liquids, including foam concentrate, fuel, and lubricants
(3) Horizontal center of gravity when full with water and other liquids
(4) Overall dimensions

15.13.4 Mounting.

15.13.4.1 The slip-on module shall be mounted in a manner that allows access to the engine, pump, and auxiliary systems for routine maintenance.

15.13.4.2 The slip-on module shall be removable using common hand tools.

15.13.4.3 The slip-on module shall be mounted in a manner that prevents damage by vibration.

15.13.4.4* Special anchorage shall be provided on the vehicle chassis and on the slip-on fire-fighting module to secure the fire-fighting module to the vehicle chassis.

15.13.4.5 The anchorage described in 15.13.4.4 shall be designed to prevent movement of the slip-on module during rapid acceleration or deceleration.

15.13.4.6 Drilling on chassis frame flanges or welding to chassis frame shall not be permitted.

Chapter 16 Fire Pumps and Associated Equipment

16.1 Application. If the apparatus is equipped with a fire pump, the provisions of this chapter shall apply.

16.2 Design and Performance Requirements.

16.2.1 Fire Pump Rated Capacity.

16.2.1.1 The fire pump shall be mounted on the apparatus and shall have a minimum rated capacity of 250 gpm (1000 L/min) at 150 psi (1000 kPa) net pump pressure.

16.2.1.2 Pumps of higher capacity shall be rated at one of the capacities specified in Table 16.2.4.1(a).

16.2.2* Where the apparatus is designed for "pump-and-roll" operations, the vehicle drive engine and drive train shall be arranged so that the pump can deliver at least 20 gpm (76 L/min) at a gauge pressure of 80 psi (550 kPa) while the fire apparatus is moving at 2 mph (3.2 kmph) or less.

16.2.3 Pumping System Capability.

16.2.3.1 If the pumping system is rated at 3000 gpm (12,000 L/min) or less, it shall be capable of delivering the following:

(1) One hundred percent of rated capacity at 150 psi (1000 kPa) net pump pressure
(2) Seventy percent of rated capacity at 200 psi (1400 kPa) net pump pressure
(3) Fifty percent of rated capacity at 250 psi (1700 kPa) net pump pressure

16.2.3.2* If the pumping system is rated at over 3000 gpm (12,000 L/min), it shall be capable of delivering the following:

(1) One hundred percent of rated capacity at 100 psi (700 kPa) net pump pressure
(2) Seventy percent of rated capacity at 150 psi (1000 kPa) net pump pressure
(3) Fifty percent of rated capacity at 200 psi (1400 kPa) net pump pressure

16.2.3.3 When dry, the pump system shall be capable of meeting the requirements of 16.2.3.3.1 through 16.2.3.3.4.

16.2.3.3.1 Where pumps are rated at less than 1500 gpm (6000 L/min), they shall be capable of taking suction through 20 ft (6 m) of suction hose under the conditions specified in Table 16.2.4.1(a) for the rated capacity of the pump and discharging water in not more than 30 seconds.

16.2.3.3.2 Where pumps are of 1500 gpm (6000 L/min) or larger capacity, they shall be capable of taking suction through 20 ft (6 m) of suction hose under the conditions specified in Table 16.2.4.1(a) for the rated capacity of the pump and discharging water in not more than 45 seconds.

16.2.3.3.3 Where the pump system includes an auxiliary 4 in. (100 mm) or larger intake pipe having a volume of 1 ft^3 (0.03 m^3) or more, an additional 15 seconds beyond that allowed in 16.2.3.3.1 and 16.2.3.3.2 shall be permitted.

16.2.3.3.4* Where pumps are of the parallel/series type, they shall complete the requirements of 16.2.3.3.1 through 16.2.3.3.3 in both parallel and series operation.

16.2.3.4 Vacuum.

16.2.3.4.1 The completed pumping system shall be capable of developing a vacuum of 22 in. Hg (75 kPa) at altitudes up to 2000 ft (600 m) by means of the pump priming system and sustaining the vacuum for at least 5 minutes with a loss not to exceed 10 in. Hg (34 kPa).

16.2.3.4.2 The requirement in 16.2.3.4.1 shall be met with all intake valves open, with all intakes capped or plugged, with all discharge caps removed, and without the use of the pump primer during the 5-minute period.

16.2.4 Pump Suction Capability.

16.2.4.1* The pump manufacturer shall certify that the fire pump is capable of pumping 100 percent of rated capacity at 150 psi (1000 kPa) net pump pressure for pumps rated 3000 gpm (12,000 L/min) or less or at 100 psi (700 kPa) for pumps rated greater than 3000 gpm (12,000 L/min) from draft through 20 ft (6 m) of suction hose with a strainer attached under the following conditions:

(1) An altitude of 2000 ft (600 m) above sea level
(2) Atmospheric pressure of 29.9 in. Hg (101 kPa) (corrected to sea level)
(3) Water temperature of 60°F (15.6°C)
(4) Suction hose size and number of hose not to exceed those indicated in Table 16.2.4.1(a)
(5) Lift as indicated in Table 16.2.4.1(a)
(6) Friction and entrance loss in suction hose, including strainer, as given in Table 16.2.4.1(b) or Table 16.2.4.1(c)

Table 16.2.4.1(a) Suction Hose Size, Number of Suction Lines, and Lift for Pump Manufacturer's Suction Capability Certification

Rated Capacity		Suction Hose Size		Number of Suction Lines	Lift	
gpm	L/min	in.	mm		ft	m
250	1,000	3	75	1	10	3
300	1,100	3	75	1	10	3
350	1,300	4	100	1	10	3
500	2,000	4½	100	1	10	3
750	3,000	4½	110	1	10	3
1000	4,000	6	150	1	10	3
1250	5,000	6	150	1	10	3
1500	6,000	6	150	2	10	3
1750	7,000	6	150	2	8	2.4
2000	8,000	6	150	2	6	1.8
2000	8,000	8	200	1	6	1.8
2250	9,000	6	150	3	6	1.8
2250	9,000	8	200	1	6	1.8
2500	10,000	6	150	3	6	1.8
2500	10,000	8	200	1	6	1.8
3000	12,000	6	150	4	6	1.8
3000	12,000	8	200	2	6	1.8
3500	14,000	6	150	4	6	1.8
3500	14,000	8	200	2	6	1.8
4000	16,000	6	150	4	6	1.8
4000	16,000	8	200	2	6	1.8

Table 16.2.4.1(b) Friction and Entrance Loss in 20 ft of Suction Hose, Including Strainer (inch-pound units)

Flow Rate (gpm)	Number of Suction Hose and Size (inside diameter)									
	One 3 in.		One 4 in.		One 4½ in.		One 5 in.		One 6 in.	
	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg
250	5.2 (1.2)	4.6								
175	2.6 (0.6)	2.3								
125	1.4 (0.3)	1.2								
300	7.5 (1.7)	6.6								
210	3.8 (0.8)	3.4								
150	1.9 (0.4)	1.7								
350			2.5 (0.7)	2.1						
245			1.2 (0.3)	1.1						
175			0.7 (0.1)	0.6						
500			5.0 (1.3)	4.4	3.6 (0.8)	3.2				
350			2.5 (0.7)	2.1	1.8 (0.4)	1.6				
250			1.3 (0.4)	1.1	0.9 (0.3)	0.8				
750			11.4 (2.9)	9.8	8.0 (1.6)	7.1	4.7 (0.9)	4.2	1.9 (0.4)	1.7
525			5.5 (1.5)	4.9	3.9 (0.8)	3.4	2.3 (0.5)	2.0	0.9 (0.2)	0.8
375			2.8 (0.7)	2.5	2.0 (0.4)	1.8	1.2 (0.2)	1.1	0.5 (0.1)	0.5
1000					14.5 (2.8)	12.5	8.4 (1.6)	7.4	3.4 (0.6)	3.0
700					7.0 (1.4)	6.2	4.1 (0.8)	3.7	1.7 (0.3)	1.5
500					3.6 (0.8)	3.2	2.1 (0.4)	1.9	0.9 (0.2)	0.8
	One 5 in.		One 6 in.		Two 4½ in.		Two 5 in.		Two 6 in.	
	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg
1250	13.0 (2.4)	11.5	5.2 (0.9)	4.7	5.5 (1.2)	4.9				
875	6.5 (1.2)	5.7	2.6 (0.5)	2.3	2.8 (0.7)	2.5				
625	3.3 (0.7)	2.9	1.3 (0.3)	1.1	1.4 (0.3)	1.2				
1500			7.6 (1.4)	6.7	8.0 (1.6)	7.1	4.7 (0.9)	4.2	1.9 (0.4)	1.7
1050			3.7 (0.7)	3.3	3.9 (0.8)	3.4	2.3 (0.5)	2.0	0.9 (0.3)	0.8
750			1.9 (0.4)	1.7	2.0 (0.4)	1.8	1.2 (0.2)	1.1	0.5 (0.1)	0.5
1750			10.4 (1.8)	9.3	11.0 (2.2)	9.7	6.5 (1.2)	5.7	2.6 (0.5)	2.3
1225			5.0 (0.9)	4.6	5.3 (1.1)	4.7	3.1 (0.7)	2.7	1.2 (0.3)	1.1
875			2.6 (0.5)	2.3	2.8 (0.6)	2.5	1.6 (0.3)	1.4	0.7 (0.2)	0.6
2000					14.5 (2.8)	12.5	8.4 (1.6)	7.4	3.4 (0.6)	3.0
1400					7.0 (1.4)	6.2	4.1 (0.8)	3.7	1.7 (0.3)	1.5
1000					3.6 (0.8)	3.2	2.1 (0.4)	1.9	0.9 (0.2)	0.8
2250							10.8 (2.2)	9.5	4.3 (0.8)	3.8
1575							5.3 (1.1)	4.7	2.2 (0.4)	1.9
1125							2.8 (0.5)	2.5	1.1 (0.2)	1.0
2500							13.0 (2.4)	11.5	5.2 (0.9)	4.7
1750							6.5 (1.2)	5.7	2.6 (0.5)	2.3
1250							3.3 (0.7)	2.9	1.3 (0.3)	1.1
	Two 6 in.		Three 6 in.		Four 6 in.		One 8 in.		Two 8 in.	
	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg
2000	3.4 (0.6)	3.0					4.3 (1.1)	3.8		
1400	1.7 (0.3)	1.5					2.0 (0.6)	1.8		
1000	0.9 (0.2)	0.8					1.0 (0.3)	0.9		
2250	4.3 (0.8)	3.8	2.0 (0.5)	1.8			5.6 (1.4)	5.0	1.2 (0.4)	1.1
1575	2.2 (0.4)	1.9	1.0 (0.2)	0.9			2.5 (0.9)	2.2	0.6 (0.2)	0.5
1125	1.1 (0.2)	1.0	0.5 (0.1)	0.5			1.2 (0.4)	1.1	0.3 (0.1)	0.3
2500	5.2 (0.9)	4.7	2.3 (0.6)	2.0			7.0 (1.7)	6.2	1.5 (0.4)	1.3
1750	2.6 (0.5)	2.3	1.2 (0.2)	1.1			3.2 (1.0)	2.8	0.8 (0.2)	0.7
1250	1.3 (0.3)	1.1	0.6 (0.1)	0.5			1.5 (0.4)	1.3	0.4 (0.1)	0.4
3000	7.6 (1.4)	6.9	3.4 (0.6)	3.0			10.1 (3.0)	9.0	2.3 (0.6)	2.1
2100	3.7 (0.7)	3.4	1.7 (0.3)	1.5			4.7 (1.3)	4.2	1.0 (0.3)	0.9
3500	10.4 (1.8)	9.3			2.6 (0.5)	2.3			3.2 (0.8)	2.8
2450	5.0 (0.9)	4.6			1.2 (0.3)	1.1			1.5 (0.4)	1.3
4000			4.8 (0.9)	4.3	3.4 (0.6)	3.0			4.3 (1.1)	3.8
2800			2.8 (0.5)	2.5	1.7 (0.3)	1.5			2.0 (0.6)	1.8

Note: Figures in parentheses indicate increment to be added or subtracted for each 10 ft of hose greater than or less than 20 ft.

Table 16.2.4.1(c) Friction and Entrance Loss in 6 m of Suction Hose, Including Strainer (SI units)

Flow Rate (L/min)	Number of Suction Hose and Size (inside diameter)									
	One 75 mm		One 100 mm		One 110 mm		One 125 mm		One 150 m	
	m water	kPa	m water	kPa	m water	kPa	m water	kPa	m water	kPa
1,000	1.6 (0.04)	16								
700	0.8 (0.02)	8								
500	0.4 (0.01)	4								
1,100	2.2 (0.05)	22								
770	1.1 (0.02)	12								
550	0.6 (0.01)	6								
1,300			0.7 (0.02)	7						
910			0.4 (0.01)	4						
650			0.2 (0.01)	2						
2,000			1.5 (0.04)	15	1.1 (0.02)	11				
1,400			0.7 (0.02)	7	0.5 (0.01)	5				
1,000			0.4 (0.01)	4	0.3 (0.01)	3				
3,000			3.5 (0.09)	33	2.4 (0.05)	24	1.4 (0.03)	14	0.6 (0.01)	6
2,100			1.7 (0.05)	17	1.2 (0.02)	11	0.7 (0.01)	7	0.3 (0.01)	3
1,500			0.9 (0.02)	8	0.6 (0.01)	6	0.4 (0.01)	4	0.2 (0.01)	2
4,000					4.4 (0.08)	42	2.6 (0.05)	25	1.0 (0.02)	10
2,800					2.1 (0.04)	21	1.2 (0.02)	13	0.5 (0.01)	5
2,000					1.1 (0.02)	11	0.6 (0.01)	6	0.3 (0.01)	3
	One 125 mm		One 150 mm		Two 110 mm		Two 125 mm		Two 150 mm	
	m water	kPa	m water	kPa	m water	kPa	m water	kPa	m water	kPa
5,000	4.0 (0.07)	39	1.6 (0.03)	16	1.7 (0.04)	17				
3,500	2.0 (0.04)	19	0.8 (0.02)	8	0.9 (0.02)	8				
2,500	1.0 (0.02)	10	0.4 (0.01)	4	0.4 (0.01)	4				
6,000			2.3 (0.04)	23	2.4 (0.05)	24	1.4 (0.03)	14	0.6 (0.01)	6
4,200			1.1 (0.02)	11	1.2 (0.02)	12	0.7 (0.02)	7	0.3 (0.01)	3
3,000			0.6 (0.01)	6	0.6 (0.01)	6	0.4 (0.01)	4	0.2 (0.01)	2
7,000			3.2 (0.05)	31	3.6 (0.07)	33	2.0 (0.04)	19	0.8 (0.02)	8
4,900			1.5 (0.03)	16	1.6 (0.03)	16	0.9 (0.02)	9	0.4 (0.01)	4
3,500			0.8 (0.02)	8	0.9 (0.02)	8	0.5 (0.01)	5	0.2 (0.01)	2
8,000					4.4 (0.08)	42	2.6 (0.05)	25	1.0 (0.02)	10
5,600					2.1 (0.04)	21	1.2 (0.02)	13	0.5 (0.01)	5
4,000					1.1 (0.02)	11	0.6 (0.01)	6	0.3 (0.01)	3
9,000							3.3 (0.07)	32	1.3 (0.02)	13
6,300							1.6 (0.03)	16	0.7 (0.01)	6
4,500							0.9 (0.02)	8	0.3 (0.01)	3
10,000							4.0 (0.07)	39	1.6 (0.03)	16
7,000							2.0 (0.04)	19	0.8 (0.02)	8
5,000							1.0 (0.02)	10	0.4 (0.01)	4
	Two 150 mm		Three 150 mm		Four 150 mm		One 200 mm		Two 200 mm	
	m water	kPa	m water	kPa	m water	kPa	m water	kPa	m water	kPa
8,000	1.0 (0.02)	10					1.3 (0.03)	13		
5,600	0.5 (0.01)	5					0.6 (0.02)	6		
4,000	0.3 (0.01)	3					0.3 (0.01)	3		
9,000	1.3 (0.02)	13	0.6 (0.01)	6			1.7 (0.05)	17	0.4 (0.01)	4
6,300	0.7 (0.01)	6	0.3 (0.01)	3			0.7 (0.03)	7	0.2 (0.01)	2
4,500	0.3 (0.01)	3	0.2 (0.01)	2			0.4 (0.01)	4	0.1 (0.01)	1
10,000	1.6 (0.03)	16	0.7 (0.02)	7			2.1 (0.05)	21	0.5 (0.01)	4
7,000	0.8 (0.02)	8	0.4 (0.01)	4			1.0 (0.03)	9	0.2 (0.01)	2
5,000	0.4 (0.01)	4	0.2 (0.01)	2			0.5 (0.01)	4	0.1 (0.01)	1
12,000	2.3 (0.04)	23	1.0 (0.02)	10			3.0 (0.09)	30	0.7 (0.02)	7
8,400	1.1 (0.02)	12	0.5 (0.01)	5			1.4 (0.04)	14	0.3 (0.01)	3
14,000	3.2 (0.05)	31			0.8 (0.2)	8			1.0 (0.2)	9
9,800	1.5 (0.03)	16			0.4 (0.1)	4			0.5 (0.1)	4
16,000			1.5 (0.3)	15	1.0 (0.2)	10			1.3 (0.3)	13
11,200			0.9 (0.2)	8	0.5 (0.1)	5			0.6 (0.2)	6

Note: Figures in parentheses indicate increment to be added or subtracted for each 3 m of hose greater than or less than 6 m.

16.2.4.2* The pump manufacturer shall certify that the pump is capable of pumping rated capacity at 150 psi (1000 kPa) net pump pressure for pumps rated 3000 gpm (12,000 L/min) or less or at 100 psi (700 kPa) for pumps rated greater than 3000 gpm (12,000 L/min) at any of the following special conditions when these conditions are specified by the purchaser:

(1) At an elevation above 2000 ft (600 m)
(2) At lifts higher than those listed in Table 16.2.4.1(a), through more than 20 ft (6 m) of suction hose, or both
(3) For pumps having a rated capacity of 1500 gpm (6000 L/min) or larger, through a single suction hose only, or through the number of hose listed in Table 16.2.4.1(a) attached to one side of the apparatus only

16.3 Pumping Engine Requirements.

16.3.1 The apparatus manufacturer shall approve the use of the pumping engine for stationary pumping applications based on the size of the fire apparatus and the rating of the pump being furnished.

16.3.2 Engine Speed.

16.3.2.1 The engine shall be capable of performing the pumping tests herein specified without exceeding the maximum governed speed of the engine as shown on a certified brake horsepower curve of the type of engine used without accessories.

16.3.2.2 The brake horsepower curve certification shall be signed by a responsible official of the engine manufacturer.

16.3.3 If the fire pump is rated at 750 gpm (3000 L/min) or greater but not greater than 3000 gpm (12,000 L/min), the engine/pump combination shall be capable of delivering the rated pump capacity at 165 psi (1100 kPa) net pump pressure.

16.3.4* If a separate pumping engine is provided, it shall meet the requirements of 12.2.1.1, 12.2.1.2, 12.2.1.7, 12.2.2, 12.2.3.1, 12.2.3.2, 12.2.4 through 12.2.6, Section 13.2, 13.4.3, 13.4.4, 13.4.4.1, 13.4.4.3, 13.4.4.4, 13.4.5, Section 13.5, and Section 13.6.

16.3.5 A supplementary heat exchanger cooling system shall be provided for the pump drive engine.

16.3.5.1 Valving shall be installed to permit water from the discharge side of the pump to cool the coolant circulating through the engine cooling system without intermixing.

16.3.5.2 The heat exchanger shall maintain the temperature of the coolant in the pump drive engine not in excess of the engine manufacturer's temperature rating under all pumping conditions.

16.3.5.3 A drain(s) shall be provided to allow draining of the heat exchanger so as to prevent damage from freezing.

16.3.6 Indicator or Light.

16.3.6.1 Where a separate engine is used to drive the pump, an indicator or light that is energized when the pump engine is running shall be provided in the driving compartment.

16.3.6.2 The indicator or light shall be marked with a label that reads "Pump Engine Running."

16.4 Power Train Capability.

16.4.1 All components in the power train from the engine to the fire pump shall be capable of transmitting the torque necessary to power the pump, as installed in the apparatus, for the pump performance points specified in 16.2.3.1 and 16.2.3.2, if applicable, without exceeding the component manufacturer's continuous duty torque rating.

16.4.2 When pumping continuously at each of the pump performance points specified in 16.2.3.1 and 16.2.3.2, if applicable, lubricant temperatures in any power train component installed in the apparatus from the engine to the pump shall not exceed the component manufacturer's recommendation for maximum temperature.

16.4.3* A means shall be provided to limit the nominal net engine output during pumping operation to a torque level equal to the nominal continuous duty torque rating of the weakest component or, if there are multiple devices to be driven simultaneously, to a level equal to the sum of the nominal continuous duty torque ratings of multiple components.

16.5 Construction Requirements.

16.5.1* Wetted moving parts shall be constructed of a corrosion-resistant material.

16.5.2 Hydrostatic Test.

16.5.2.1 The pump body shall be subjected to a hydrostatic test to a gauge pressure of 500 psi (3400 kPa) for a minimum of 10 minutes.

16.5.2.2 The pump manufacturer shall provide a certificate of completion for the hydrostatic test.

16.5.3 The entire discharge and intake piping system, valves, drain cocks and lines, and intake and outlet closures, excluding the tank fill and tank-to-pump lines on the tank side of the valves in those lines, shall be capable of withstanding a hydrostatic gauge pressure of 500 psi (3400 kPa).

16.5.4 Pulsation-Free Fire Streams.

16.5.4.1 The pump shall be capable of producing fire streams that are free from pulsations. ?

SHOULD STATE "SHALL PROVIDE STREAMS THAT ARE FREE FROM PULSATIONS."

16.5.4.2 When an accumulator is used to provide pulsation-free fire streams, the accumulator shall be constructed and tested in accordance with the ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 2.

16.5.5 The pump shall allow a positive pressure water source to directly add to the pump's discharge pressure.

16.6 Pump Intake Connections.

16.6.1* The pump shall have a sufficient number and size of intakes to perform the apparatus pump system certification test.

16.6.1.1 The intakes specified in 16.6.1 shall have male National Hose threads if the apparatus is to be used in the United States.

16.6.1.2 If the couplings on the suction hose carried on the apparatus are of a different size from that of the pump intake(s) or have means of hose attachment other than that provided on the intake(s), an adapter(s) shall be provided to allow connection of the suction hose to the pump intake(s).

16.6.1.3* A sign shall be provided on the pump operator's panel that states the following:

> **WARNING:** Death or serious injury might occur if proper operating procedures are not followed. The pump operator as well as individuals connecting supply or discharge hoses to the apparatus must be familiar with water hydraulics hazards and component limitations.

16.6.2 Intake Strainer.

16.6.2.1 Each intake shall have a removable or accessible strainer inside the connection.

16.6.2.2* The strainer(s) shall restrict spherical debris that is too large to pass through the pump.

16.6.3 At least one valved intake shall be provided that can be controlled from the pump operator's position.

16.6.3.1 The valve and piping shall be a minimum 2½ in. (65 mm) nominal size.

16.6.3.2 If the intake is 2½ in. (65 mm) nominal size, the intake shall be equipped with a female swivel coupling with NH threads.

16.6.4 Any 3 in. (75 mm) or larger intake valve except the tank-to-pump intake valve shall be a slow-operating valve.

16.6.5* Each valved intake shall be equipped with a bleeder valve having a minimum ¾ in. (19 mm) pipe thread connection to bleed off air or water.

16.6.5.1 The bleeder valve shall be operational without the operator having to get under the apparatus.

16.6.5.2 If a valved appliance is attached to an intake, it shall be equipped with a ¾ in. (19 mm) bleeder valve on each intake.

16.6.5.3 Bleeder valves for valved intakes 4 in. (100 mm) and larger not located at the pump operator's panel shall be located where the bleeder valve controls are visible and operationally functional while the operator remains stationary at the valved intake position.

16.6.6 Each valved intake having a connection size larger than 3 in. (75 mm) shall be equipped with an adjustable automatic pressure relief device installed on the supply side of the valve to bleed off pressure from a hose connected to the valved intake.

16.6.6.1 The pressure relief device shall discharge to atmosphere, and the discharge shall be piped or directed away from the pump operator's position.

16.6.6.2 The automatic pressure relief device shall be adjustable from a minimum of 90 psi (620 kPa) to at least 185 psi (1275 kPa).

16.6.6.3 The pressure relief device, when preset at 125 psi (860 kPa), shall not allow a pressure rise greater than 60 psi (400 kPa) at the device inlet while flowing a minimum of 150 gpm (570 L/min).

16.6.7 If the pump is equipped with one or more intakes larger than 3 in. (75 mm) that are not valved, an adjustable automatic pressure relief device shall be installed on the pump system to bleed off excess pressure from a hose connected to the pump intake.

16.6.7.1 The automatic pressure relief device shall be adjustable from a minimum of 90 psi (620 kPa) to at least 185 psi (1275 kPa).

16.6.7.2 The pressure relief device, when preset at 125 psi (860 kPa), shall not allow a pressure rise greater than 60 psi (400 kPa) at the device inlet while flowing a minimum of 150 gpm (570 L/min).

16.6.7.3 The pressure relief device shall discharge to atmosphere.

16.6.8 All intakes shall be provided with caps or closures capable of withstanding a hydrostatic gauge pressure of 500 psi (3400 kPa).

16.6.8.1 Intakes having male threads shall be equipped with caps; intakes having female threads shall be equipped with plugs.

16.6.8.2 Where adapters for special threads or other means for hose attachment are provided on the intakes, closures shall be provided for the adapters in lieu of caps or plugs.

16.6.9 Caps or closures for intake connections smaller than 4 in. (100 mm) shall remain secured to the apparatus when removed from the connection.

16.6.10 If the suction inlets are to be equipped with a valve, siamese, or adapter that will remain in place while the apparatus is in motion, that valve, siamese, or adapter shall not project beyond the apparatus running board.

16.6.11 The purchaser shall specify if any valve, siamese, or adapter is to be permanently installed on an intake and identify the brand and model of such item.

16.7* Pump Discharge Outlets.

16.7.1* Discharge outlets of 2½ in. (65 mm) or larger shall be provided to discharge the rated capacity of the pump at the flow rates shown in Table 16.7.1.

Table 16.7.1 Discharge Rates by Outlet Size

Outlet Size		Flow Rates	
in.	mm	gpm	L/min
2½	65	250	1000
3	75	375	1400
4	100	625	2400
5	125	1000	4000
6	150	1440	5500

16.7.1.1 If the apparatus is equipped with an aerial device with a waterway that is permanently connected to the pump, the discharge from that waterway shall be permitted to be credited as a 1000 gpm (4000 L/min) outlet.

16.7.1.2 A minimum of two 2½ in. (65 mm) outlets shall be provided on any pump rated at 750 gpm (3000 L/min) or greater, and a minimum of one 2½ in. (65 mm) outlet shall be provided on any pump rated at less than 750 gpm (3000 L/min).

16.7.2 Discharge Outlet Connections.

16.7.2.1 All 2½ in. (65 mm) or larger discharge outlet connections shall be equipped with male National Hose threads.

16.7.2.2* Adapters with special threads or other means for hose attachment shall be permitted to be attached to any outlets.

16.7.3* The piping and valves supplying any preconnected 1½ in. (38 mm), 1¾ in. (45 mm), or 2 in. (52 mm) hose line, including the piping to the preconnected hose storage areas specified in Section 5.6(2), Section 6.5(2), 7.5.2, 8.6.2, Section 9.6(2), or Section 11.7(2), as applicable, shall be at least 2 in. (52 mm) in size.

16.7.4 All discharge outlet connections, except connections to which a hose will be preconnected, shall be equipped with caps or closures capable of withstanding a hydrostatic gauge pressure of 100 psi (700 kPa) over the maximum pump close-off pressure or 500 psi (3400 kPa), whichever is greater.

16.7.4.1 Where adapters are provided on the discharge outlet connections, the closures shall fit on the adapters.

16.7.4.2 Caps or closures for outlet connections smaller than 4 in. (100 mm) shall remain secured to the apparatus when removed from the connection.

16.7.5 Each discharge outlet shall be equipped with a valve that can be opened and closed smoothly at the flows shown in Table 16.7.1 at pump discharge gauge pressures of 250 psi (1700 kPa).

16.7.5.1 The flow-regulating element of each valve shall not change its position under any condition of operation that involves discharge pressures to the maximum pressure of the pump; the means to prevent a change in position shall be incorporated in the operating mechanism and shall be permitted to be manually or automatically controlled.

16.7.5.2* Any 3 in. (75 mm) or larger discharge valve shall be a slow-operating valve.

16.7.6 All 1½ in. (38 mm) or larger discharge outlets shall be equipped with a drain or bleeder valve having a minimum ¾ in. (19 mm) pipe thread connection for draining or bleeding off pressure from a hose connected to the outlet.

16.7.7 Any 2 in. (52 mm) or larger discharge outlet that is located more than 42 in. (1070 mm) off the ground to which hose is to be connected and that is not in a hose storage area shall be supplied with a sweep elbow of at least 30 degrees downward.

16.7.8 Valves.

16.7.8.1 Each pump discharge shall have a valve that can be controlled from the pump operator's position.

16.7.8.2 A secondary valve shall be permitted to be provided at a discharge outlet if required for special applications.

16.7.9* Location of Discharge Outlets.

16.7.9.1 No discharge outlet larger than 2½ in. (65 mm) shall be located at the pump operator's panel.

16.7.9.2 If the apparatus has a top console–type pump operator's panel, vertical discharge outlets larger than 2½ in. (65 mm) shall be permitted at the top midship position of apparatus where the outlets are used for directly connected deck guns or monitors and no fire hose is used for coupling the components.

16.7.10 Where the valve-operating mechanism does not indicate the position of the valve, an indicator shall be provided to show when the valve is closed.

16.8 Pump Drains.

16.8.1 A readily accessible drain valve(s) that is marked with a label as to its function shall be provided to allow for draining of the pump and all water-carrying lines and accessories.

16.8.2 The drain valve(s) shall be operational without the operator having to get under the apparatus.

16.9 Pump Operator's Panel.

16.9.1* Each pump control, gauge, and other instrument necessary to operate the pump shall be located on a panel known as the pump operator's panel and shall be marked with a label as to its function.

16.9.2 All gauges, discharge outlets, pump intakes, and controls shall be illuminated in compliance with 4.10.1.

16.10* Pump Controls.

16.10.1 General Provisions. Provisions shall be made for placing the pump drive system in operation using controls and switches that are identified and within convenient reach of the operator.

16.10.1.1 Where the pump is driven by the chassis engine and engine compression brakes or engine exhaust brakes are furnished, these engine brakes shall be automatically disengaged for pumping operations.

16.10.1.2* Any control device used in the pumping system power train between the engine and the pump, except a manual pump shift override device if provided, shall be equipped with a means to prevent unintentional movement of the control device from its set position in the pumping mode.

16.10.1.3 A label indicating the chassis transmission shift selector position to be used for pumping shall be provided in the driving compartment and located so that it can be read from the driver's position.

16.10.1.4 Where the pump is driven by the chassis engine and transmission through a split shaft PTO, the driving compartment speedometer shall register when the pump drive system is engaged.

16.10.1.5 Where chassis transmission retarders are furnished, they shall be automatically disengaged for pumping operations.

16.10.1.6 Where the pump is driven by the chassis engine and an automatic chassis transmission through a split-shaft PTO, the chassis transmission shall shift to neutral upon engagement of the parking brake.

16.10.2 Stationary Pump Driven Through Split-Shaft PTO — Automatic Chassis Transmission. Where the apparatus is equipped with an automatic chassis transmission, the water pump is driven by the chassis engine through the transmission's main driveline, and the apparatus is to be used for stationary pumping only, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pumping system can be operated from the pump operator's position.

16.10.2.1* A "Pump Engaged" indicator shall be provided in the driving compartment to indicate that the pump shift process has been successfully completed.

16.10.2.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged, the chassis transmission is in pump gear, and the parking brake is engaged.

16.10.3 Stationary Pump Driven Through Split-Shaft PTO — Manual Chassis Transmission. Where the apparatus is equipped with a manual chassis transmission, the water pump is driven by the chassis engine through the transmission's main driveline, and the apparatus is to be used for stationary pumping only, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pumping system can be operated from the pump operator's position.

16.10.3.1* A "Pump Engaged" indicator shall be provided in the driving compartment to indicate that the pump shift has been successfully completed.

16.10.3.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged and the parking brake is engaged.

16.10.4 Stationary Pump Driven Through Transmission-Mounted PTO, Front-of-Engine Crankshaft PTO, or Engine Flywheel PTO — Automatic Chassis Transmission. Where the apparatus is equipped with an automatic chassis transmission, the water pump is driven by a transmission-mounted (SAE) PTO, front-of-engine crankshaft PTO, or engine flywheel PTO, and the apparatus is to be used for stationary pumping only with the chassis transmission in neutral, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pump system can be operated from the pump operator's position.

16.10.4.1 A "Pump Engaged" indicator shall be provided both in the driving compartment and on the pump operator's panel to indicate that the pump shift has been successfully completed.

16.10.4.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged, the chassis transmission is in neutral, and the parking brake is engaged.

16.10.5 Stationary Pump Driven Through Transmission-Mounted PTO, Front-of-Engine Crankshaft PTO, or Engine Flywheel PTO — Manual Chassis Transmissions. Where the apparatus is equipped with a manual chassis transmission, the water pump is driven by a transmission-mounted (SAE) PTO, front-of-engine crankshaft PTO, or engine flywheel PTO, and the apparatus is to be used for stationary pumping only with the chassis transmission in neutral, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pump system can be operated from the pump operator's position.

16.10.5.1 A "Pump Engaged" indicator shall be provided both in the driving compartment and on the pump operator's panel to indicate that the pump shift has been successfully completed.

16.10.5.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged and the parking brake is engaged.

16.10.6 Stationary and "Pump-and-Roll" Pump — Automatic Chassis Transmissions. Where the water pump is driven by a transmission-mounted (SAE) PTO, front-of-engine crankshaft PTO, or engine flywheel PTO, and the apparatus is designed to be used in both the stationary pumping mode and the "pump-and-roll" pumping mode with the automatic chassis transmission in neutral for stationary pumping and in a road gear for pump-and-roll pumping, an interlock system shall be provided to ensure that the pump drive system components are properly engaged in the pumping mode of operation so that the apparatus can be operated in either stationary or pump-and-roll pumping mode.

16.10.6.1 A "Pump Engaged" indicator shall be provided both in the driving compartment and on the pump operator's panel to indicate that the pump shift has been successfully completed.

16.10.6.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged, the chassis transmission is in neutral, and the parking brake is engaged.

16.10.6.3 An "OK to Pump and Roll" indicator shall be provided in the driving compartment and shall be energized when the pump is engaged, the chassis transmission is in road gear, and the parking brake is released.

16.10.6.4 When the "OK to Pump and Roll" indicator is energized, the "OK to Pump" indicator shall not be energized.

16.10.7 Stationary and "Pump-and-Roll" Pumps — Manual Chassis Transmissions. Where the water pump is driven by a transmission-mounted (SAE) PTO, front-of-engine crankshaft PTO, or engine flywheel PTO, and the apparatus is designed to be used in both the stationary pumping mode and the pump-and-roll pumping mode with the chassis transmission in neutral for stationary pumping or in a road gear for pump-and-roll pumping, an interlock system shall be provided to ensure that the pump drive system components are properly engaged in the pumping mode of operation so that the apparatus can be operated in either stationary or pump-and-roll pumping mode.

16.10.7.1 A "Pump Engaged" indicator shall be provided both in the driving compartment and on the pump operator's panel to indicate that the pump shift has been successfully completed.

16.10.7.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged and the parking brake is engaged.

16.10.7.3 An "OK to Pump and Roll" indicator shall be provided in the driving compartment and shall be energized when the pump is engaged and the parking brake is released.

16.10.7.4 When the "OK to Pump and Roll" indicator is energized, the "OK to Pump" indicator shall not be energized.

16.10.8 Stationary Pumps Driven Through Transfer Case PTOs — Automatic Chassis Transmissions. Where the apparatus is equipped with an automatic chassis transmission, the water pump is driven by the chassis engine through the transmission's main driveline and through a transfer case, and the apparatus is to be used for stationary pumping only, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pumping system can be operated from the pump operator's position.

16.10.8.1 A "Pump Engaged" indicator shall be provided in the driving compartment to indicate that the pump shift has been successfully completed.

16.10.8.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged, the chassis transmission is in pump gear, the transfer case drive to the chassis wheels is in neutral, and the parking brake is engaged.

16.10.9 Stationary Pumps Driven Through Transfer Case PTOs — Manual Chassis Transmissions. Where the apparatus is equipped with a manual chassis transmission, the water pump is driven by the chassis engine through the transmission's main driveline and through a transfer case, and the apparatus is to be used for stationary pumping only, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pumping system can be operated from the pump operator's position.

16.10.9.1 A "Pump Engaged" indicator shall be provided in the driving compartment to indicate that the pump shift has been successfully completed.

16.10.9.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged, the transfer case drive to the chassis wheels is in neutral, and the parking brake is engaged.

16.10.10 Pump Operator's Panel Engine Speed Advancement — Automatic Chassis Transmission.

16.10.10.1 An engine speed control shall be provided at the pump operator's panel.

16.10.10.2 A "Throttle Ready" indicator that lights when the pump is in the "OK to Pump" mode shall be provided on the pump operator's panel.

16.10.10.3* The "Throttle Ready" indicator at the pump operator's panel shall be permitted to light when the chassis transmission is in neutral and the parking brake is engaged.

16.10.10.4 An interlock system shall be provided to prevent advancement of the engine speed at the pump operator's panel unless the apparatus has "Throttle Ready" indication.

16.10.10.5 Loss of power to the interlock system in 16.10.10.4 shall return the engine speed to idle and prevent advancement from the pump operator's panel.

16.10.11 Pump Operator's Panel Engine Speed Advancement — Manual Chassis Transmission.

16.10.11.1 An engine speed control shall be provided on the pump operator's panel.

16.10.11.2 A "Throttle Ready" indicator that lights when the pump is in the "OK to Pump" mode shall be provided on the pump operator's panel.

16.10.11.3* The "Throttle Ready" indicator on the pump operator's panel shall be permitted to light when the parking brake is engaged.

16.10.11.4 Loss of power to the interlock system in 16.10.11.3 shall return the engine speed to idle and prevent advancement from the pump operator's panel.

16.10.12 If a pump shift manual override device is provided, the "Pump Engaged," "OK to Pump," and "Throttle Ready" indicators and the pump operator's panel engine speed advancement interlock system shall be operationally functional when the manual override device is used to shift the pump.

16.10.13 Parallel/Series Control.

16.10.13.1 With parallel/series centrifugal pumps, the control positions for parallel operation (volume) and series operation (pressure) shall be indicated.

16.10.13.2 The control for changing the pump from series to parallel, and vice versa, shall be operable at the pump operator's position.

16.10.14* Pressure Control System.

16.10.14.1* A system shall be provided that, when set in accordance with the manufacturer's instructions, will automatically control the increase in net pump pressure to a maximum of 30 psi (200 kPa) pressure rise when all discharge valves are closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds during the following conditions:

(1) Over a range of pressures from 70 psi to 300 psi (500 kPa to 2000 kPa) net pump pressure with intake gauge pressure between −10 psi and 185 psi (−70 kPa and 1300 kPa) and discharge gauge pressure between 90 psi and 300 psi (620 kPa and 2000 kPa)
(2) With initial engine and pump controls set to produce a range of flows from 150 gpm (550 L/min) to the rated capacity of the pump

16.10.14.2 If the pump is equipped with a relief valve system where the system does not control engine speed, the system shall be equipped with a means to indicate when the system is in control of the pressure.

16.10.14.2.1 If the pump is equipped with a governor system that controls engine speed, an indicator shall show when the system is turned on and whether it is controlling the engine speed or pump pressure.

16.10.14.2.2 Either system shall be controllable by one person at the pump operator position.

16.10.14.3 If the system discharges water to the atmosphere, the discharge shall be in a manner that will not expose personnel to high pressure water streams.

16.10.15* Priming System. A priming system shall be provided and controlled from the pump operator's position.

16.10.15.1 The priming system shall be capable of meeting the requirements of 16.2.3.3 and 16.2.4.

16.10.15.2 The priming system shall be capable of operating with no lubricant or with a biodegradable nontoxic lubricant.

16.10.16 Protection of Pump Controls. All pump controls and devices shall be installed so as to be protected against mechanical damage and the effects of adverse weather conditions on their operation.

16.11 Pump Engine Controls.

16.11.1* A throttle control that holds its set position shall be provided to control the pump engine speed.

16.11.2 The throttle control on vertically (greater than 45 degrees) arranged pump panels shall be located not higher than 72 in. (1830 mm) nor lower than 42 in. (1070 mm) from the operator's standing position with all instruments in full view.

16.11.3 The throttle control on horizontally (less than 45 degrees) arranged pump panels shall be located not higher than 50 in. (1270 mm) nor lower than 32 in. (810 mm) from the operator's standing position with all instruments in full view.

16.12 Instrumentation.

16.12.1 Pump Operator's Panel.

16.12.1.1* The following controls and instruments shall be provided and installed as a group on the pump operator's panel:

(1) Master pump intake pressure gauge
(2) Master pump discharge pressure gauge
(3) Pumping engine tachometer

(4) Pumping engine coolant temperature gauge
(5) Pumping engine oil pressure gauge
(6) Voltmeter
(7) Pump pressure control(s)
(8) Pumping engine throttle
(9) Primer control
(10) Water tank–to–pump valve control
(11) Water tank fill valve control
(12) Water tank level gauge

16.12.1.2 The instruments and controls required by 16.12.1.1 shall be placed so as to keep the pump operator as far as practicable from all discharge and intake connections and in a location where the instruments and controls are visible and operationally functional while the operator remains stationary.

16.12.1.3 Any instrumentation exposed to the elements shall be weatherproof.

16.12.1.4 The pumping engine oil pressure and engine coolant temperature gauges shall be equipped with audible and visual warnings.

16.12.1.5 All engine operation gauges on the pump operator's panel shall be in addition to those on the vehicle's instrument panel.

16.12.2 Master Pump Intake and Discharge Pressure Gauges.

16.12.2.1 Master pump intake and pump discharge pressure gauges shall be located within 8 in. (200 mm) of each other, edge to edge, with the intake pressure gauge to the left of or below the pump discharge pressure gauge.

16.12.2.1.1 The intake pressure gauge shall read from 30 in. Hg (100 kPa) vacuum to at least a gauge pressure of 300 psi (2000 kPa).

16.12.2.1.2 The discharge pressure gauge shall read from a gauge pressure of 0 psi or lower to a gauge pressure of at least 300 psi (2000 kPa).

16.12.2.1.3 Pressure gauges shall not be damaged by a 30 in. Hg (100 kPa) vacuum.

16.12.2.1.4 Pressure gauges shall be marked with labels that read "Pump Intake" for the intake pressure gauge and "Pump Discharge" for the discharge pressure gauge.

16.12.2.2 If analog gauges are used, they shall meet the requirements of 16.12.2.2.1 through 16.12.2.2.7.

16.12.2.2.1 There shall be at least a 1 in. (25 mm) diameter differential in viewing area between the master gauges and the individual discharge gauges, with the master gauges being the larger.

16.12.2.2.2 Analog gauges displaying the vacuum portion in 45 degrees of arc or less shall have an accuracy complying with Grade 1A as defined by ASME B40.100, *Pressure Gauges and Gauge Attachments.*

16.12.2.2.3 Analog gauges displaying the vacuum portion in greater than 120 degrees of arc shall have an accuracy of 3½ percent or better on vacuum and 3½ percent or better on pressure over their entire respective scale.

16.12.2.2.4 Analog gauges displaying the vacuum portion in greater than 120 degrees of arc shall have graduation lines on the vacuum side every 1 in. Hg (5 kPa) with major and immediate graduation lines emphasized and figures at least every 10 in. Hg (50 kPa).

16.12.2.2.5 Numerals for master gauges shall be a minimum of 0.25 in. (6.4 mm) high.

16.12.2.2.6 There shall be graduation lines showing at least every 10 psi (50 kPa), with major and intermediate graduation lines emphasized, and figures at least every 100 psi (500 kPa).

16.12.2.2.7 Analog pressure gauges shall be vibration and pressure pulsation dampened; be resistant to corrosion, condensation, and shock; and have internal mechanisms that are factory lubricated for the life of the gauge.

16.12.2.3 If digital master pressure gauges are used, they shall meet the requirements of 16.12.2.3.1 through 16.12.2.3.3.

16.12.2.3.1 The digits shall be at least 0.5 in. (12.7 mm) high.

16.12.2.3.2 Digital pressure gauges shall display pressure in increments of not more than 10 psi (50 kPa).

16.12.2.3.3 Digital master pressure gauges shall have an accuracy of ±3 percent over the full scale.

16.12.3 Discharge Outlet Instrumentation.

16.12.3.1 A pressure gauge shall be provided for each discharge outlet 1½ in. (38 mm) or larger in size and shall be marked with a label to indicate the outlet to which it is connected.

16.12.3.2* Any discharge outlet that is equipped with a flowmeter shall also be provided with a pressure gauge.

16.12.3.3 The pressure gauge or flowmeter display shall be located adjacent to the corresponding valve control with no more than 6 in. (150 mm) separating the pressure gauge or flowmeter bezel and the valve control midpoint or centerline.

16.12.3.4 If both a flowmeter and a pressure gauge are provided for an individual discharge outlet, the pressure gauges shall be located within 6 in. (150 mm) of the valve control midpoint or centerline, and the flowmeter display shall be adjacent to and within 2 in. (51 mm) of the pressure gauge bezel.

16.12.3.5 Pressure gauges shall be connected to the outlet side of the valve.

16.12.3.6 Flowmeters shall display flow in increments no greater than 10 gpm (50 L/min).

16.12.3.7 Where analog pressure gauges are used, they shall have a minimum accuracy of Grade B as defined in ASME B40.100.

16.12.3.7.1 Numerals for gauges shall be a minimum 5⁄32 in. (4 mm) high.

16.12.3.7.2 There shall be graduation lines showing at least every 10 psi (50 kPa), with major and intermediate graduation lines emphasized, and figures at least every 100 psi (500 kPa).

16.12.3.7.3 Analog pressure gauges shall be vibration and pressure pulsation dampened; be resistant to corrosion, condensation, and shock; and have internal mechanisms that are factory lubricated for the life of the gauge.

16.12.3.8 If digital pressure gauges are used, they shall meet the requirements of 16.12.3.8.1 through 16.12.3.8.3.

16.12.3.8.1 The digits shall be at least ¼ in. (6.4 mm) high.

16.12.3.8.2 Digital pressure gauges shall display pressure in increments of not more than 10 psi (50 kPa).

16.12.3.8.3 Digital pressure gauges shall have an accuracy of ±3 percent over the full scale.

16.12.3.9 Each flowmeter shall be calibrated to an accuracy of ±5 percent when flowing the amount of water shown in Table 16.12.3.9 for the pipe size in which it is mounted.

16.12.4 Each pressure gauge or flowmeter and its display shall be mounted and attached so it is protected from accidental damage and excessive vibration.

Table 16.12.3.9 Flowmeter Calibration Flow for Each Pipe Size

Pipe Size		Flow	
in.	mm	gpm	L/min
1	25	40	150
1½	38	90	340
2	52	160	600
2½	65	250	950
3	75	375	1400
4	100	625	2400
5	125	1000	4000
6	150	1440	5500

16.12.5 Connections for test gauges shall be provided at the pump operator's panel.

16.12.5.1 One test gauge connection shall be connected to the intake side of the pump, and the other shall be connected to the discharge manifold of the pump.

16.12.5.2 The test gauge connections shall have a 0.25 in. (6.4 mm) standard pipe thread, shall be plugged, and shall be marked with a label.

16.13 Required Testing.

16.13.1 Apparatus Pump System Certification.

16.13.1.1 If the fire pump has a rated capacity of 750 gpm (3000 L/min) or greater, the pump shall be tested after the pump and all its associated piping and equipment have been installed on the apparatus.

16.13.1.1.1 The tests shall include at least the pumping test *(see 16.13.2)*, the pressure control system test *(see 16.13.4)*, the priming system tests *(see 16.13.5)*, the vacuum test *(see 16.13.6)*, and the gauge and flowmeter test *(see 16.13.9)*.

16.13.1.1.2 If the fire pump is rated at 750 gpm (3000 L/min) or greater but not greater than 3000 gpm (12,000 L/min), the pumping engine overload test *(see 16.13.3)* shall be included.

16.13.1.1.3 If the fire pump is driven by the chassis engine, the engine speed advancement interlock test *(see 16.13.8)* shall be included.

16.13.1.1.4 If the apparatus is equipped with a water tank, the water tank–to–pump flow test *(see 16.13.7)* shall be included.

16.13.1.1.5 An independent third-party certification organization shall witness the tests and certify the test results.

16.13.1.2 If the fire pump has a rated capacity of less than 750 gpm (3000 L/min), the pump shall be tested after the pump and all its associated piping and equipment have been installed on the apparatus.

16.13.1.2.1 The tests shall include at least the pumping test *(see 16.13.2)*, the pressure control system test *(see 16.13.4)*, the priming system tests *(see 16.13.5)*, the vacuum test *(see 16.13.6)*, and the gauge and flowmeter test *(see 16.13.9)*.

16.13.1.2.2 If the apparatus is equipped with a water tank, the water tank–to–pump flow test *(see 16.13.7)* shall be included.

16.13.1.2.3 If the fire pump is driven by the chassis engine, the engine speed advancement interlock test *(see 16.13.8)* shall be included.

16.13.1.2.4* The test results shall be certified by the apparatus manufacturer.

16.13.1.3 Test Label.

16.13.1.3.1 A test label shall be provided at the pump operator's panel that gives the rated discharges and pressures together with the speed of the engine as determined by the certification test for each unit, the position of the parallel/series pump as used, and the governed speed of the engine as stated by the engine manufacturer on a certified brake horsepower curve.

16.13.1.3.2 The label shall be completely stamped with all information at the factory and attached to the vehicle prior to shipping.

16.13.2 Pumping Test.

16.13.2.1 Conditions for Test.

16.13.2.1.1 The test site shall be adjacent to a supply of clear water at least 4 ft (1.2 m) deep and close enough to allow the suction strainer to be submerged at least 2 ft (0.6 m) below the surface of the water when connected to the pump by 20 ft (6 m) of suction hose.

16.13.2.1.2* Tests shall be performed when conditions are as follows:

(1) Air temperature: 0°F to 110°F (−18°C to 43°C)
(2) Water temperature: 35°F to 90°F (2°C to 32°C)
(3) Barometric pressure: 29 in. Hg (98.2 kPa), minimum (corrected to sea level)
(4)*Minimum lift: 3 ft (1 m) from center of pump intake to the surface of the water

16.13.2.1.3 If it is necessary to perform the test outside the air or water temperature ranges stated in 16.13.2.1.2 and the pump passes the certification test, the test results shall be acceptable.

16.13.2.1.4 Engine-driven accessories shall not be functionally disconnected or otherwise rendered inoperative during the tests.

16.13.2.1.4.1 If the chassis engine drives the pump, the total continuous electrical loads, excluding those loads associated with the equipment defined in 16.13.2.1.4.3, shall be applied for the entire pumping portion of this test.

16.13.2.1.4.2 If the vehicle is equipped with a fixed power source driven by the same engine that drives the fire pump, it shall be running at a minimum of 50 percent of its rated capacity throughout the pumping portion of the pump test.

16.13.2.1.4.3 The following devices shall be permitted to be turned off or not operating during the pump test:

(1) Aerial hydraulic pump
(2) Foam pump
(3) Hydraulically driven equipment (other than hydraulically driven line voltage generator)
(4) Winch
(5) Windshield wipers

(6) Four-way hazard flashers
(7) Compressed air foam system (CAFS) compressor

16.13.2.1.5 All structural enclosures, such as floorboards, gratings, grilles, and heat shields, not furnished with a means for opening them in service shall be kept in place during the tests.

16.13.2.2 Equipment.

16.13.2.2.1 Suction Hose.

16.13.2.2.1.1 The suction hose size and maximum number of lines during the apparatus pump system certification testing shall be as defined in Table 16.13.2.2.1.1.

Table 16.13.2.2.1.1 Suction Hose Size and Number of Suction Lines for Fire Pumps

Rated Capacity		Maximum Suction Hose Size		Maximum Number of Suction Lines*
gpm	L/min	in.	mm	
250	1,000	3	75	1
300	1,100	3	75	1
350	1,300	4	100	1
500	2,000	4	100	1
750	3,000	4½	110	1
1,000	4,000	6	150	1
1,250	5,000	6	150	1
1,500	6,000	6	150	2
1,750	7,000	6	150	2
2,000	8,000	6	150	2
2,000	8,000	8	200	1
2,250	9,000	6	150	3
2,250	9,000	8	200	1
2,500	10,000	6	150	3
2,500	10,000	8	200	1
3,000	12,000	6	150	4
3,000	12,000	8	200	2
3,500	14,000	6	150	4
3,500	14,000	8	200	2
4,000	16,000	6	150	4
4,000	16,000	8	200	2

*Where more than one suction line is used, all suction lines do not have to be the same hose size.

16.13.2.2.1.2 A suction strainer and hose that will allow flow with total friction and entrance loss not greater than that specified in Table 16.2.4.1(b) or Table 16.2.4.1(c) shall be used.

16.13.2.2.2 Sufficient fire hose shall be provided to discharge the rated capacity of the pump to the nozzles or other flow measuring equipment without exceeding a flow velocity of 35 ft/sec (10 m/sec) [approximately 500 gpm (2000 L/min) for 2½ in. (65 mm) hose].

16.13.2.2.3 Where nozzles are used, they shall be smoothbore, and the inside diameters shall be from ¾ in. to 2½ in. (19 mm to 63.5 mm).

16.13.2.2.4 Test Gauges.

16.13.2.2.4.1 All test gauges shall meet the requirements for Grade A gauges as defined in ASME B40.100 and shall be at least size 3½ per ASME B40.100.

16.13.2.2.4.2 A mercury manometer shall be permitted to be used in lieu of a pump intake gauge.

16.13.2.2.4.3 The pump intake gauge shall have a range of 30 in. Hg (100 kPa) vacuum to zero for a vacuum gauge or 30 in. Hg (100 kPa) vacuum to a gauge pressure of 150 psi (1000 kPa) for a compound gauge.

16.13.2.2.4.4 The discharge pressure gauge shall have a gauge pressure range of 0 psi to 400 psi (0 kPa to 2800 kPa).

16.13.2.2.4.5 Pitot gauges shall have a gauge pressure range of at least 0 psi to 160 psi (0 kPa to 1100 kPa).

16.13.2.2.4.6 All gauges shall be calibrated in the month preceding the tests using a dead-weight gauge tester or a master gauge meeting the requirements for Grade 3A or 4A gauges, as defined in ASME B40.100, that has been calibrated within the preceding year.

16.13.2.2.5 Each test gauge connection shall include a means for "snubbing," such as a needle valve to damp out rapid needle movements.

16.13.2.2.6* The engine speed–measuring equipment shall consist of a nonadjustable tachometer supplied from the engine or transmission electronics, a revolution counter on a checking shaft outlet and a stop watch, or other engine speed–measuring means that is accurate to within ±50 rpm of actual speed.

16.13.2.3 Procedure.

16.13.2.3.1* The ambient air temperature, water temperature, vertical lift, elevation of test site, and atmospheric pressure (corrected to sea level) shall be determined and recorded prior to and after each pump test.

16.13.2.3.2* The engine, pump, transmission, and all parts of the apparatus shall exhibit no undue heating, loss of power, or other defect during the entire test.

16.13.2.3.3 Engine Speed Check.

16.13.2.3.3.1 A check of the no-load governed speed of the engine shall be made and recorded.

16.13.2.3.3.2 If the engine speed is not within 2 percent of the rated no-load governed speed as recorded on the manufacturer engine curve, the manufacturer shall adjust the engine speed to within acceptable limits.

16.13.2.3.4 If the apparatus is equipped with a fire pump rated at 750 gpm (3000 L/min) or greater but not greater than 3000 gpm (12,000 L/min), the pump shall be subjected to a 3-hour pumping test from draft consisting of 2 hours of continuous pumping at rated capacity at a minimum of 150 psi (1000 kPa) net pump pressure, followed by ½ hour of continuous pumping at 70 percent of rated capacity at a minimum of 200 psi (1400 kPa) net pump pressure and ½ hour of continuous pumping at 50 percent of rated capacity at a minimum of 250 psi (1700 kPa) net pump pressure.

16.13.2.3.4.1 The pump shall not be stopped until after the 2-hour test at rated capacity, unless it becomes necessary to clean the suction strainer.

16.13.2.3.4.2 The pump shall be permitted to be stopped between tests in order to change the hose or nozzles, clean the strainer, or add fuel for the pump drive engine.

16.13.2.3.4.3 The capacity, discharge pressure, intake pressure, and engine speed shall be recorded at least every 15 minutes but not fewer than three times for each test sequence.

16.13.2.3.4.4 The average net pump pressure shall be calculated and recorded based on the average values for discharge and intake pressure.

16.13.2.3.5 If the apparatus is equipped with a fire pump rated at greater than 3000 gpm (12,000 L/min), the pump shall be subjected to a 3-hour pumping test from draft consisting of 2 hours of continuous pumping at rated capacity at a minimum of 100 psi (700 kPa) net pump pressure, followed by ½ hour of continuous pumping at 70 percent of rated capacity at a minimum of 150 psi (1000 kPa) net pump pressure and ½ hour of continuous pumping at 50 percent of rated capacity at a minimum of 200 psi (1400 kPa) net pump pressure.

16.13.2.3.5.1 The pump shall not be stopped until after the 2-hour test at rated capacity, unless it becomes necessary to clean the suction strainer.

16.13.2.3.5.2 The pump shall be permitted to be stopped between tests in order to change the hose or nozzles, clean the strainer, or add fuel for the pump drive engine.

16.13.2.3.5.3 The capacity, discharge pressure, intake pressure, and engine speed shall be recorded at least every 15 minutes but not fewer than three times for each test sequence.

16.13.2.3.5.4 The average net pump pressure shall be calculated and recorded based on the average values for discharge and intake pressure.

16.13.2.3.6 If the apparatus is equipped with a fire pump rated at less than 750 gpm (3000 L/min), the pump shall be subjected to a 50-minute pumping test from draft consisting of 30 minutes of continuous pumping at rated capacity at a minimum of 150 psi (1000 kPa) net pump pressure, followed by 10 minutes of continuous pumping at 70 percent of rated capacity at a minimum of 200 psi (1400 kPa) net pump pressure, and 10 minutes of continuous pumping at 50 percent of rated capacity at a minimum of 250 psi (1700 kPa) net pump pressure.

16.13.2.3.6.1 The pump shall not be stopped until after the 30-minute test at rated capacity, unless it becomes necessary to clean the suction strainer.

16.13.2.3.6.2 The pump shall be permitted to be stopped between tests in order to change the hose or nozzles or clean the strainer.

16.13.2.3.6.3 The capacity, discharge pressure, intake pressure, and engine speed shall be recorded at least every 10 minutes but not fewer than three times for each test sequence.

16.13.2.3.6.4 The average net pump pressure shall be calculated and recorded based on the average values for discharge and intake pressure.

16.13.3 Pumping Engine Overload Test. If the pump has a rated capacity of 750 gpm (3000 L/min) or greater but not greater than 3000 gpm (12,000 L/min), the apparatus shall be subjected to an overload test consisting of pumping rated capacity at 165 psi (1100 kPa) net pump pressure for at least 10 minutes.

16.13.3.1 This test shall be performed immediately following the pumping test of rated capacity at 150 psi (1000 kPa).

16.13.3.2 The capacity, discharge pressure, intake pressure, and engine speed shall be recorded at least three times during the overload test.

16.13.4 Pressure Control System Test.

16.13.4.1 If the pump is rated at 3000 gpm (12,000 L/min) or less, the pressure control system on the pump shall be tested as follows:

(1) The pump shall be operated at draft, delivering rated capacity at a discharge gauge pressure of 150 psi (1000 kPa).
(2) The pressure control system shall be set in accordance with the manufacturer's instructions to maintain the discharge gauge pressure at 150 psi (1000 kPa) ± 5 percent.
(3) All discharge valves shall be closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds.
(4) The rise in discharge pressure shall not exceed 30 psi (200 kPa) and shall be recorded.
(5) The original conditions of pumping rated capacity at a discharge gauge pressure of 150 psi (1000 kPa) shall be re-established.
(6) The discharge pressure gauge shall be reduced to 90 psi (620 kPa) by throttling the engine fuel supply, with no change to the discharge valve settings, hose, or nozzles.
(7) The pressure control system shall be set according to the manufacturer's instructions to maintain the discharge gauge pressure at 90 psi (620 kPa) ± 5 percent.
(8) All discharge valves shall be closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds.
(9) The rise in discharge pressure shall not exceed 30 psi (200 kPa) and shall be recorded.
(10) The pump shall be operated at draft, pumping 50 percent of rated capacity at a discharge gauge pressure of 250 psi (1700 kPa).
(11) The pressure control system shall be set in accordance with the manufacturer's instructions to maintain the discharge gauge pressure at 250 psi (1700 kPa) ± 5 percent.
(12) All discharge valves shall be closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds.
(13) The rise in discharge pressure shall not exceed 30 psi (200 kPa) and shall be recorded.

16.13.4.2 If the pumping system is rated at greater than 3000 gpm (12,000 L/min), the pressure control system on the pump shall be tested as follows:

(1) The pump shall be operated at draft, delivering rated capacity at a discharge gauge pressure of 100 psi (700 kPa).
(2) The pressure control system shall be set in accordance with the manufacturer's instructions to maintain the discharge gauge pressure at 100 psi (700 kPa) ± 5 percent.
(3) All discharge valves shall be closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds.
(4) The rise in discharge pressure shall not exceed 30 psi (200 kPa) and shall be recorded.
(5) The original conditions of pumping rated capacity at a discharge gauge pressure of 150 psi (1000 kPa) shall be re-established.
(6) The pump shall be operated at draft, pumping 50 percent of rated capacity at a discharge gauge pressure of 200 psi (1400 kPa).
(7) The pressure control system shall be set in accordance with the manufacturer's instructions to maintain the discharge gauge pressure at 200 psi (1400 kPa) ± 5 percent.
(8) All discharge valves shall be closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds.
(9) The rise in discharge pressure shall not exceed 30 psi (200 kPa) and shall be recorded.

16.13.5 Priming System Tests. With the apparatus set up for the pumping test, the primer shall be operated in accordance with the manufacturer's instructions until the pump has been primed and is discharging water.

16.13.5.1 This test shall be permitted to be performed in connection with priming the pump for the pumping test.

16.13.5.2 The interval from the time the primer is started until the time the pump is discharging water shall be noted.

16.13.5.3 The time required to prime the pump shall not exceed 30 seconds if the rated capacity is 1250 gpm (5000 L/min) or less.

16.13.5.4 The time required to prime the pump shall not exceed 45 seconds if the rated capacity is 1500 gpm (6000 L/min) or more.

16.13.5.5 An additional 15 seconds shall be permitted in order to meet the requirements of 16.13.5.3 and 16.13.5.4 when the pump system includes an auxiliary 4 in. (100 mm) or larger intake pipe having a volume of 1 ft^3 (0.03 m^3) or more.

16.13.5.5.1 The additional 15 seconds shall not apply to valved intake pipes such that when the valve is closed, the pipe volume between the fire pump and the valve is reduced to less than 1 ft^3 (0.03 m^3).

16.13.6 Vacuum Test. The vacuum test shall consist of subjecting the interior of the pump, with all intake valves open, all intakes capped or plugged, and all discharge caps removed, to a vacuum of 22 in. Hg (75 kPa) by means of the pump priming system.

16.13.6.1 At altitudes above 2000 ft (600 m), the vacuum attained shall be permitted to be less than 22 in. Hg (75 kPa) by 1 in. Hg (3.4 kPa) for each 1000 ft (300 m) of altitude above 2000 ft (600 m).

16.13.6.2 The primer shall not be used after the 5-minute test period has begun.

16.13.6.3 The engine shall not be operated at any speed greater than the governed speed during this test.

16.13.6.4 The vacuum shall not drop more than 10 in. Hg (34 kPa) in 5 minutes.

16.13.6.5* The vacuum test shall then be repeated with all intake valves closed and the caps or plugs on all gated intakes removed.

16.13.7 Water Tank–to–Pump Flow Test.

16.13.7.1 A water tank–to–pump flow test shall be conducted as follows:

(1) The water tank shall be filled until it overflows.
(2) All intakes to the pump shall be closed.
(3) The tank fill line and bypass cooling line shall be closed.
(4) A hose line(s) and nozzle(s) for discharging water at the rated tank-to-pump flow rate shall be connected to one or more discharge outlets.
(5) The tank-to-pump valve(s) and the discharge valve(s) leading to the hose line(s) and nozzle(s) shall be fully opened.
(6) The engine throttle shall be adjusted until the required flow rate −0/+5 percent is established *(see 18.3.2)*.
(7) The discharge pressure shall be recorded.
(8) The discharge valves shall be closed and the water tank refilled.
(9) The bypass cooling line shall be permitted to be opened temporarily, if needed, to keep the water temperature in the pump within acceptable limits.
(10) The discharge valves shall be fully reopened and the time noted.
(11) If necessary, the engine throttle shall be adjusted to maintain the discharge pressure recorded as noted in 16.13.7.1(7).
(12) When the discharge pressure drops by 10 psi (70 kPa) or more, the time shall be noted and the elapsed time from the opening of the discharge valves shall be calculated and recorded.

16.13.7.2 Volume Discharge Calculation.

16.13.7.2.1 The volume discharged shall be calculated by multiplying the rate of discharge in gallons per minute (liters per minute) by the time in minutes elapsed from the opening of the discharge valves until the discharge pressure drops by at least 10 psi (70 kPa).

16.13.7.2.2 Other means shall be permitted to be used to determine the volume of water pumped from the tank, such as a totalizing flowmeter, weighing the fire apparatus before and after, or refilling the tank using a totalizing flowmeter.

16.13.7.3 The rated tank-to-pump flow rate shall be maintained until 80 percent of the rated capacity of the tank has been discharged.

16.13.8* Engine Speed Advancement Interlock Test. The engine speed advancement interlock system shall be tested to verify that engine speed cannot be increased at the pump operator's panel unless there is throttle-ready indication.

16.13.8.1 If the apparatus is equipped with a stationary pump driven through split-shaft PTO, the test shall verify that the engine speed control at pump operator's panel cannot be advanced when either of the following conditions exists:

(1) The chassis transmission is in neutral, the parking brake is off, and the pump shift in the driving compartment is in the road position.
(2) The chassis transmission has been placed in the position for pumping as indicated on the label provided in the driving compartment, the parking brake is on, and the pump shift in the driving compartment is in the road position.

16.13.8.2 If the apparatus is equipped with a stationary pump driven through a transmission mounted PTO, front-of-engine crankshaft PTO, or engine flywheel PTO, the test shall verify that the engine speed control on the pump operator's panel cannot be advanced when either of the following conditions exists:

(1) The chassis transmission is in neutral, the parking brake is off, and the pump shift status in the driving compartment is disengaged.
(2) The chassis transmission is in any gear other than neutral, the parking brake is on, and the pump shift in the driving compartment is in the "Pump Engaged" position.

16.13.8.3 If the apparatus is equipped with a pump driven by the chassis engine designed for both stationary pumping and pump-and-roll, the test shall verify that the engine speed control at pump operator's panel cannot be advanced when either of the following conditions exists:

(1) The chassis transmission is in neutral, the parking brake is on, and the pump shift status in the driving compartment is disengaged.

(2) The chassis transmission is in any gear other than neutral, the parking brake is on, and the pump shift in the driving compartment is in the "Pump Engaged" or the "OK to Pump & Roll" position.

16.13.8.4 If the apparatus is equipped with a stationary pump driven through transfer case PTO, the test shall verify that the engine speed control on the pump operator's panel cannot be advanced when one of the following conditions exists:

(1) The chassis transmission is in neutral, the transfer case is in neutral, the parking brake is off, and the pump shift in the driving compartment is in the road position.
(2) The chassis transmission is in neutral, the transfer case is engaged, the parking brake is off, and the pump shift in the driving compartment is in the road position.
(3) The chassis transmission has been placed in the position for pumping as indicated on the label provided in the driving compartment, the parking brake is on, and the pump shift in the driving compartment is in the road position.

16.13.9 Gauge and Flowmeter Test.

16.13.9.1 Pump intake and discharge pressure gauges shall be checked for accuracy while pumping at rated capacity at 150 psi (1000 kPa).

16.13.9.2 Any gauge that is off by more than 10 psi (70 kPa) from the calibrated test gauge shall be recalibrated, repaired, or replaced.

16.13.9.3 Each flowmeter shall be checked for accuracy while pumping water at rated capacity at 100 psi (700 kPa).

16.13.9.4 Any flowmeter that is off by more than 10 percent shall be recalibrated, repaired, or replaced.

16.13.10* Manufacturer's Predelivery Test.

16.13.10.1 The manufacturer shall conduct a piping hydrostatic test prior to delivery of the apparatus.

16.13.10.2 The test shall be conducted as follows:

(1) The pump and its connected piping system shall be hydrostatically tested to a gauge pressure of 250 psi (1700 kPa).
(2) The hydrostatic test shall be conducted with the tank fill line valve, the bypass line valve if so equipped, and the tank-to-pump valve closed.
(3) All discharge valves shall be open and the outlets capped.
(4) All intake valves shall be closed, and nonvalved intakes shall be capped.
(5) This pressure shall be maintained for 3 minutes.

Chapter 17 Auxiliary Pumps and Associated Equipment

17.1* Application. If the apparatus is equipped with an auxiliary pump, the provisions of this chapter shall apply.

17.2 Pump Performance.

17.2.1 Auxiliary pumps shall be rated as either high pressure or medium pressure.

17.2.2 The performance of a high pressure auxiliary pump shall be a minimum of 66 gpm (250 L/min) at 600 psi (4000 kPa) discharge pressure for each high pressure hose reel connected to it that can be operated simultaneously with other high pressure hose reels.

17.2.3 Medium Pressure Auxiliary Pumps.

17.2.3.1 The pump shall have one of the following rated capacities: 30 gpm (115 L/min), 60 gpm (230 L/min), 90 gpm (345 L/min), 120 gpm (460 L/min), 250 gpm (1000 L/min), or 350 gpm (1300 L/min).

17.2.3.2 The pump shall be capable of pumping 100 percent of its rated capacity at 150 psi (1000 kPa) discharge pressure, 70 percent of its rated capacity at 200 psi (1400 kPa) discharge pressure, and 50 percent of its rated capacity at 250 psi (1700 kPa) discharge pressure.

17.2.4 The rating for auxiliary pumps shall be based on the pump taking water from the apparatus water tank.

17.2.5 Where an auxiliary pump is provided in combination with a fire pump and the pumps are interconnected so that pressure from one pump can be transmitted to the other pump, check valves, intake or discharge relief valves, pump drive gear ratios, or other automatic means shall be provided to avoid pressurizing either pump beyond its maximum hydrostatic test pressure.

17.3* Power Train Capability.

17.3.1* All components in the power train from the engine to the pump shall be capable of transmitting the continuous duty power required by the pump for at least 50 minutes at the pump's rated capacity and pressure.

17.3.2* When pumping rated capacity and pressure, lubricant temperatures in any power train component shall not exceed the component manufacturer's recommendation for maximum temperature.

17.4 Construction Requirements. The pump, piping, and valves shall be capable of withstanding a minimum hydrostatic pressure of 100 psi (700 kPa) above the maximum pump close off pressure.

17.5 Pump Intakes.

17.5.1* Each pump intake shall be sized to permit the full rated performance of the pump and shall be equipped with a valve that can be controlled from the pump operator's position.

17.5.2 Each external intake shall be equipped with National Hose threads on the connection, a removable or accessible strainer, and a bleeder valve to bleed off air or water from a hose connected to the intake.

17.5.2.1 Adapters with special threads or other means for hose attachment shall be permitted on any intake connection.

17.5.2.2 All intake connections shall be provided with closures capable of withstanding a hydrostatic gauge pressure of 500 psi (3400 kPa).

17.5.2.2.1 Intake connections having male threads shall be equipped with caps; intake connections having female threads shall be equipped with plugs.

17.5.2.2.2 Where adapters for special threads or other means for hose attachment are provided on the intake connections, closures shall be provided for the adapters in lieu of caps or plugs.

17.5.2.3 Caps or closures for intake connections smaller than 4 in. (100 mm) shall remain secured to the apparatus when removed from the connection.

17.6* Pump Discharges.

17.6.1 Each pump discharge shall be equipped with a valve that can be controlled from the pump operator's position.

17.6.2 Any discharge that can be supplied from both the auxiliary pump and the fire pump shall have check valves in both supply lines to prevent backflow into the other pump.

17.6.3 Discharge Outlet Connections.

17.6.3.1* All discharge outlet connections shall be equipped with male National Hose threads.

17.6.3.2 Adapters with special threads or other means for hose attachment shall be permitted to be attached to any discharge outlet connection.

17.6.4 All discharge outlet connections, except connections to which a hose will be preconnected, shall be equipped with caps or closures capable of withstanding a hydrostatic gauge pressure of 100 psi (700 kPa) over the maximum pump close-off pressure or 500 psi (3400 kPa), whichever is greater.

17.6.4.1 Where adapters are provided on the discharge outlet connection, the closures shall fit on the adapters.

17.6.4.2 Caps or closures for outlet connections smaller than 4 in. (100 mm) shall remain secured to the apparatus when removed from the connection.

17.6.5 If a water tank fill line is provided, the line shall be connected from the pump discharge manifold directly to the water tank and shall include a valve that can be controlled from the pump operator's position.

17.7 Pump Operator's Panel.

17.7.1 Each pump control, gauge, and other instrument necessary to operate the auxiliary pump shall be located on a panel known as the pump operator's panel and shall be marked with a label as to its function.

17.7.2 All gauges, instruments, discharge outlets, pump intakes, and controls located on the auxiliary pump operator's panel shall be illuminated in compliance with 4.10.1.

17.8 Pump Controls.

17.8.1 Controls shall be provided for placing the pump in operation.

17.8.2 The control for the pump engagement mechanism shall be marked with a label to indicate when the pump is properly engaged in pumping position.

17.8.3 Parallel/Series Control.

17.8.3.1 With parallel/series centrifugal pumps, the positions for parallel operation (volume) and series operation (pressure) shall be indicated.

17.8.3.2 The control for changing the pump from series to parallel, and vice versa, shall be located on the pump operator's panel.

17.8.4 If more than one discharge outlet is provided, a relief valve or other pressure control device shall be provided that is capable of limiting the pump discharge pressure.

17.8.5 All pump controls and devices shall be installed so as to be protected against mechanical damage or the effects of adverse weather conditions on their operation.

17.8.6 Drain Valve(s).

17.8.6.1 A readily accessible drain valve(s) that is marked with a label as to its function shall be provided to allow the pump and all water-carrying lines and accessories to be drained.

17.8.6.2 The drain valve(s) shall be operational without the operator having to get under the apparatus.

17.8.7 A bypass line of not less than ¼ in. (6.4 mm) diameter that has a valve that can be controlled from the pump operator's position or an automatic-type control shall be installed from the discharge manifold directly to the water tank or ground.

17.9 Pump Drive Systems.

17.9.1 Where the pump is driven by a transmission-mounted (SAE) PTO, front-of-engine crankshaft PTO, or flywheel PTO, the provisions of 16.10.4 through 16.10.7 shall apply as applicable.

17.9.2 Where the pump is driven by a chassis transmission-mounted (SAE) PTO and the pump system does not conform to 16.4.2, a visible or audible warning device shall be provided on the pump operator's panel that is actuated if the temperature of the lubricant in the chassis transmission exceeds the transmission manufacturer's recommended maximum temperature.

17.9.3* If a separate pumping engine is provided, it shall meet the requirements of 12.2.1.1, 12.2.1.2, 12.2.1.7, 12.2.2, 12.2.3.1, 12.2.3.2, 12.2.4 through 12.2.6, Section 13.2, 13.4.3, 13.4.4, 13.4.4.1, 13.4.4.3, 13.4.4.4, 13.4.5, Section 13.5, and Section 13.6.

17.9.4 Where a separate engine is used to drive the auxiliary pump, an amber indicator light marked with a label that reads "Pump Engine Running" shall be provided in the driving compartment and shall be energized when the pump engine is running.

17.10 Engine Controls.

17.10.1 A throttle control that holds its set position shall be provided to control the engine speed. It shall be located so that it can be manipulated from the pump operator's position with all instrumentation in full view.

17.10.2 This throttle control shall be permitted to be the same throttle control that is used for the main fire pump.

17.11 Gauges and Instruments.

17.11.1 Master Pump Discharge Pressure Gauge. A master discharge pressure gauge shall be provided.

17.11.1.1 It shall read from a gauge pressure of 0 to at least 300 psi (2100 kPa) but not less than 100 psi (700 kPa) higher than the maximum pressure that can be developed by the pump when it is operating with zero intake pressure.

17.11.1.2 Where an analog pressure gauge is used, it shall have a minimum accuracy of Grade 1A as defined in ASME B40.100, *Pressure Gauges and Gauge Attachments.*

17.11.1.2.1 Numerals for master gauges shall be a minimum 0.25 in. (6.4 mm) high.

17.11.1.2.2 There shall be graduation lines showing at least every 10 psi (50 kPa), with major and intermediate graduation lines emphasized and figures at least every 100 psi (500 kPa).

17.11.1.2.3 Analog pressure gauges shall be vibration and pressure pulsation dampened; be resistant to corrosion, condensation, and shock; and have internal mechanisms that are factory lubricated for the life of the gauge.