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USDA Forest Service WILDLAND FIRE ENGINE GUIDE

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USDA Forest Service
San Dimas Technology & Development Center
San Dimas, California

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National Wildland Fire Engine Committee (NWFEC)

The NWFEC, formed in 1997, is staffed by experts in the fields of engineering, fire, fleet, and safety. The committee provides the U. S. Department of Agriculture (USDA) Forest Service (FS) with flexible engine standard guidelines to help meet unique regional needs. The guidelines help the agency balance cost effectiveness with performance, focus on the user's operational needs, and achieve the highest degree of safety possible.

The NWFES established a charter, approved by the Director of Fire and Aviation Management, to provide the following direction:

1. Direct the development of mission standards that meet Forest Service mobile fire equipment needs.
2. Facilitate technology transfer among regions by selection of the "best of the best" of existing designs and specifications.
3. Facilitate an exchange of ideas with the National Wildland Coordinating Group (NWCG) Fire Equipment Working Team (FEWT).
4. Oversight and direction provided by the San Dimas Technology and Development Center (SDTDC).

To accomplish the charter, the committee established the following objectives for the Forest Service Wildland Fire Engine project:

1. Develop a set of standards against which all wildland fire engines will be evaluated.
2. Work with other national organizations on standards which set requirements for the equipment performance and safety of wildland fire engines.
3. Identify commercially available fire engines, or packages, which can be used in wildland fire.
4. Work with manufacturers to influence changes that will result in better and safer products.
5. Coordinate with General Services Administration (GSA) and vendors to place products on schedule.
6. Publish a guide to provide information on the products tested, considerations needed when selecting a vehicle/slip-on unit combination, options available for each product, product comparison, and other pertinent data.

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NWFEC and SDTDC developed this first edition of the Forest Service Wildland Fire Engine Guide. This publication is designed to provide fire management personnel with an easy to use reference to assist with the purchase of fire apparatus and support vehicles that meet Forest Service Standard Guidelines.

Field users are encouraged to invite industry participation for wildland fire engines in which they have interest. This guide, on the SDTDC web site, http://fsweb.stdcd.wo.fs.fed.us, will be updated as inspection and performance evaluations are completed.

This guide has three chapters:

Chapter 1, NWFEC Wildland Fire Engine Classes, defines LP, A, B, C, and D engine classes based on fire behavior and the corresponding suppression equipment performance requirements.

Chapter 2, Standard Guidelines for Forest Service Wildland Fire Engine, presents standards, along with supporting rationale on design characteristics determined to be essential to wildland fire engines.

Chapter 3, Evaluation Results and Descriptions of Wildland Fire Engines Tested, provides the results of tests performed at SDCTC and brief descriptions with photographs of each apparatus tested.

Appendix A provides the user with information on past experiences, design considerations, and wildland engine performance issues that are important in the design of new fire engines.

Choosing an Engine to Purchase

Step 1: To begin using this guide, identify the wildland fire engine class of interest using the explanation of engine classes in Chapter 1. Review the criteria to identify those fire engine characteristics that correspond with the needs for your geographic area.

Step 2: With the fire engine class identified, review table 3, NWFEC Standard Guidelines for Forest Service Wildland Fire Engines.The table summarizes the design, performance, safety, documentation, standardization, and operational criteria developed by the NWFES. The table presents the criteria as required (R), desired (D), and optional (O) for each NWFEC fire engine class. Criteria that are identified as required are the minimum national standards for equipment and performance to be included on FS wildland fire engines. The user is cautioned to implement all of the required criteria; they were developed to reflect safety and national mobility as well as local considerations.

Step 3: Next, examine Chapter 3, Evaluation Results and Descriptions of Wildland Fire Engines Tested. The results of engines tested to the standard guidelines at SDTDC identify those wildland engines—in the class of interest—that provide the desired suppression characteristics.

Step 4: With the fire engine of choice identified, the user should then contact their fleet equipment manager or the appropriate acquisition representative.

The GSA has established contract schedules for many of the commercially available fire engines, which makes purchasing quick and easy. The Federal Acquisition Regulation (FAR) contains specific language regarding the simplified acquisition process for items that are contained on GSA contract schedules. Items on GSA contract schedules are already determined to have a fair and reasonable price, and should not require additional efforts by the ordering office. (See the FAR. Using schedule 8.404 (a).) This section of the FAR allows the purchase of items on schedules without seeking further competition.

Appendix B provides a web site to GSA purchasing system vendors. The user is cautioned that GSA is not obligated to verify that the fire equipment meets FS standards. Using the USDA Forest Service Wildland Fire Engine Guide in conjunction with the GSA schedule of vendors will help ensure that wildland fire vehicles and equipment match approved FS design, performance, and safety standards as presented within this guide.

Developing a New Wildland Fire Engine

Review appendix A for additional information on design and performance information. Resources for design information are available from the groups identified under Additional Resources for Design and Use Information.

Develop a bid package for the demonstration/prototype unit. Include in the bid package the requirement to have the wildland engine evaluated to the all of criteria listed for the class.

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When the newly developed fire engine is complete—and the user is satisfied with its performance—the unit will be evaluated against the fire engine criteria by SDTDC. The manufacturer pays the cost of the evaluation. The results of the evaluation will be published in the next revision of this guide and added to the appropriate table on the SDTDC web site for use by all FS units. Additionally, the user should pursue establishing GSA pricing for the unit.

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NWFEC WILDLAND FIRE ENGINE CLASSES

The committee's approach in developing wildland fire engine classes was based on fire behavior and its associated suppression equipment needs; increasing fire activity requires greater suppression ability. The committee developed the following fire engine class mission definitions based on their combined fire experience and fire engine capability needs for critical parameters: engine capability, pump capacity, tank size, crew size in relationship to fire behavior, fire intensity, burning index, and rate of spread. While other fire engine typing or classes exist, their purpose is different than the focus of the committee. Note: As used in this guide, the terms wildland fire engine (or variants thereof) include the light patrol and slip-on fire packages.

Class LP

Mission: Wildland fire engine will combat very low intensity and low rate of spread fires. Engine will support the prescribed fire.

Equipment Selection: Gross vehicle weight rating (GVWR), tank size, and pump parameters were selected to meet the needs of a light, fast response vehicle in order to satisfy the mission.

Operational Concept: Fire suppression equipment will be easy to operate and require no particular certification for operation. Expect little or minimal training to operate engine. Vehicle requires only basic drivers license. A crew of 1 or 2 people is needed.

Class A

Mission: Wildland fire engine will combat low intensity and low rate of spread fires. Engine will support the prescribed fire.

Equipment Selection: GVWR, tank size, and pump parameters were selected to meet the needs of a light, fast response engine in order to satisfy the mission.

Operational Concept: Fire suppression equipment will be easy to operate and requires no particular certification for operation. Expect little or minimal training to operate engine. Vehicle requires only a basic drivers license. A crew of 1 or 2 people is needed.

Class B

Mission: Wildland fire engine will combat fires with low to moderate intensity with low to moderate rates of spread. Engine will support the prescribed fire.

Equipment Selection: GVWR, tank size, and pump parameters were selected to meet the needs of a fast response engine in order to satisfy the mission.

Operational Concept: Vehicle is fast response, good power to weight ratio, and maneuverable. Pump provides moderate lift capability, and the tank supports multi-mission needs. Crews will be certified and require a low number of training hours for engine operation. A crew of 2 to 3 people is required.

Class C

Mission: Wildland fire engine will combat moderate to high intensity fires with moderate to rapid rates of spread. Engine will support the prescribed fire.

Equipment Selection: GVWR**,** tank size, and pump parameters were selected to meet the needs of a fast response engine in order to satisfy the mission.

Operational Concept: Vehicle is fast response, good power to weight ratio, and maneuverable. Pump requires moderate training hours for engine operation. A crew of 3 to 5 people is required.

Class D

Mission: Combat high intensity fires with moderate to rapid rates of spread. Engine will support the prescribed fire. Supplies water to elevated locations that support numerous crews.

Equipment Selection: GVWR, tank size, and pump parameters were selected in order to satisfy the needs of a fast response engine to meet the mission.

Operational Concept: Vehicle is fast response, good power to weight ratio, and maneuverable. Pump provides high lift capability. Crews will be certified and require moderate training for engine operation. A crew of 3 to 5 people is required.

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To meet these definitions, the committee established the minimum values for pump capacity (bench rating of gpm and psi), chassis size, tank capacity, and crew size. Table 1 summarizes the NWFEC Wildland Fire Engine Classes to meet the mission definitions.

Table 1—Engine classes (engine capability) LP, A, B, C, and D.

Wildland Engine Class (engine capability) LP, A, B, C, and D					
Class	**LP**	**A**	**B**	**C**	**D**
Pump (bench rating)					
GPM	8	20	50	90	200
@pressure (psi)	65	100	200	300	300
Tank Size Minimum	50	50	200	300	500
Crew Size	1–2	1–2	2–3	3–5	3–5

Figure 1 is a graphical presentation of the committee's concept of increasing fire behavior and increasing suppression capacity of wildland engines. While each class of wildland engine is intended for suppression in a specific fire behavior region, larger capacity wildland engines are capable of meeting the missions of lesser capacity. The extended dashed lines represent this concept from the corners of suppression design region for the larger class fire engines.

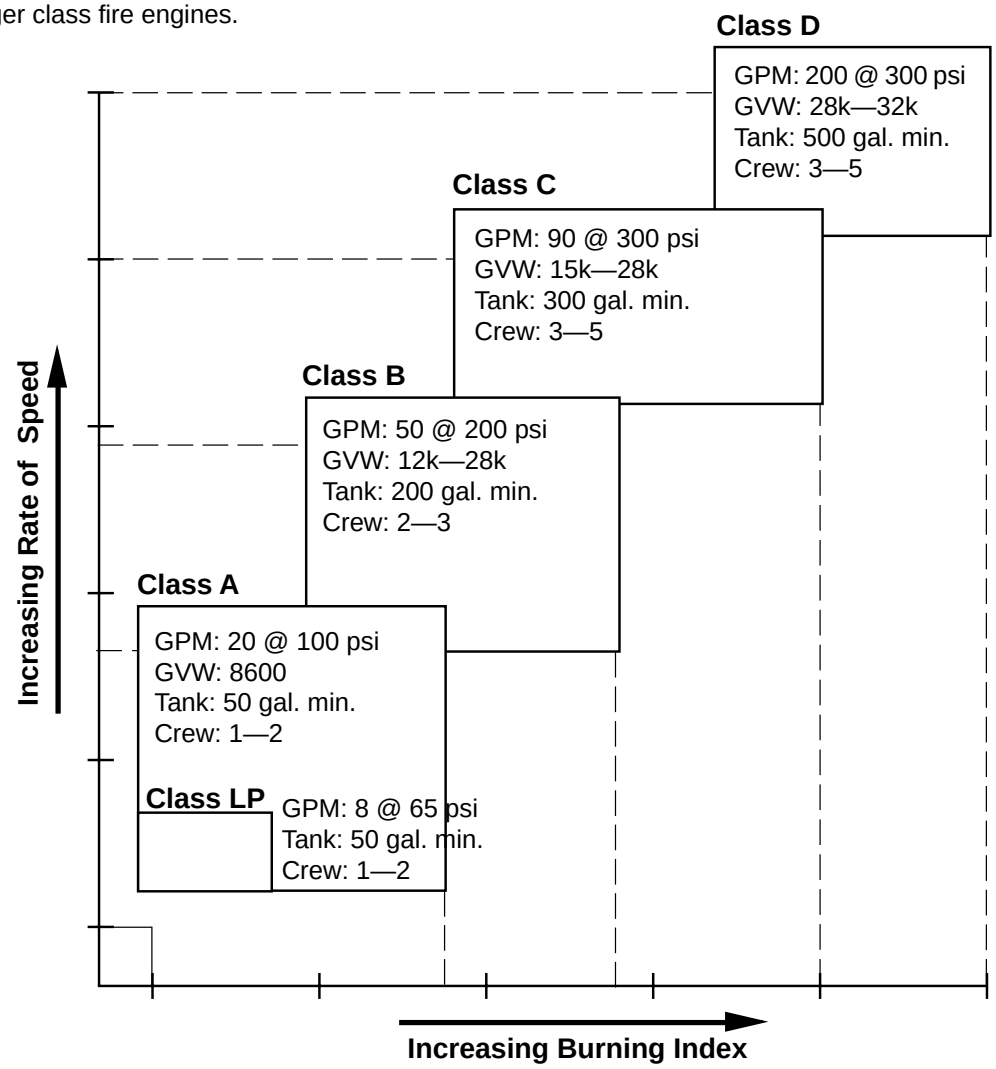

Figure 1—Wildland fire engine capability: pump capacity, tank size, crew size in relation to fire behavior—fire intensity, burning index, and rate of spread.

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Figure 2 is provided to illustrate the relationship between the NWCG Engine Typing System and the NWFEC Wildland Fire Engine Classes. Direct comparison is difficult because of the multiple parameters of each system. Therefore, pump capability is the predominate measure for the comparison below.

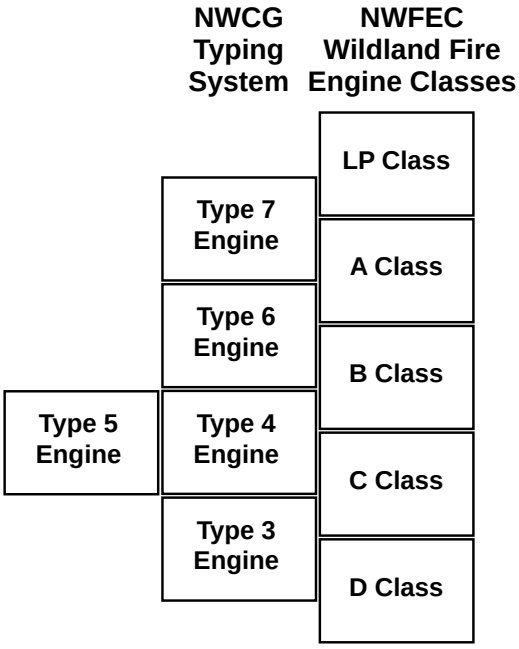

Figure 2—Engine types and engine class comparisons.

NWCG Engine Types

Using the Fire Equipment Working Team (FEWT) and the National Fire Protection Association (NFPA), the National Wildfire Coordinating Group (NWCG) categorizes information on fire engines into logical groups and provides common options often requested by fire managers. The Incident Command System (ICS) uses this engine type system based on the equipment. The NWFEC Wildland Fire Engine Classes used throughout this guide (LP, A, B, C, and D) are based on its mission and engine capability in relation to fire behavior. Table 2 shows NWCG minimum requirements for engine and water tender resource types.

Table 2—NWCG Engine Types—Minimum Requirements.

	STRUCTURE ENGINES		WILDLAND ENGINES				
Components	1	2	3	4	5	6	7
Pump Rating							
minimum flow (gpm)	1000+	250+	150	50	50	30	10
at rated pressure (psi)	150	150	250	100	100	100	100
Tank Capacity Range (gal)	400+	400+	500+	750+	400–750	150–400	50–200
Hose (feet)							
2-1/2 inch	1200	1000	~	~	~	~	~
1-1/2 inch	400	500	500	300	300	300	~
1 inch	~	~	500	300	300	300	200
Ladders (ft)	48	48	~	~	~	~	~
Master Stream (GPM)	500	~	~	~	~	~	~
Personnel (minimum)	4	3	2	2	2	2	2

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Wildland engine types are described below.

Type 3—An engine that features a high-volume and high-pressure pump. The GVWR is generally greater than 20,000 pounds.

Type 4—A heavy engine with large water capacity. Chassis GVWR is in excess of 26,000 pounds.

Type 5—Normally an initial attack engine on a medium duty chassis. GVWR of the chassis is in the 16,000 to 26,000 pound range.

Type 6—Normally an initial attack engine on a medium duty chassis. GVWR of the chassis is in the 9,000 to 16,000 pound range.

Type 7—A light duty vehicle usually on a 6,500 to 10,000 pound GVWR chassis. The vehicle has a small pump and is a multipurpose unit used for patrol, mop up, or initial attack.

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Criteria for Standard Guidelines for Forest Service Wildland Fire Engines

NWFEC has developed this set of performance and design criteria for Forest Service wildland fire engines. Engines available in each class have been tested against the NWFEC standard set of performance and design criteria at SDTDC. The criteria are written in “shall” compliance form. The NWFEC Standard Guidelines are shown in table 3. This table provides a matrix defining which criteria are required for each class of wildland fire engine.

Table 3—Criteria for Standard Guidelines for Forest Service Wildland Fire Engines.

	KEY:		**R**	Required – must have, mandatory		**O** Optional – buyer's choice					
			D	Desired – recommended item		**NA** Not Applicable					
				Engine Class			**LP**	**A**	**B**	**C**	**D**
1			**Engine Characteristics (Engine Capability)**								
	1			Required Pump Flow							
		a			GPM (minimum)		8	20	50	90	200
		b			@ pressure (psi)		65	100	200	300	300
	2			Required Tank Size							
		a			minimum (gal)		50	50	200	300	500
	3			Desired Crew Size			1–2	1–2	2–3	3–5	3–5
2			**Engine Configuration**								
	1		Integral Units (with storage cabinetry)								
		a			PTO		NA	NA	NA	O	R
		b			Auxiliary Engine		NA	NA	NA	O	NA
	2		Slip-on Units								
				Pickup or Utility Body (storage cabinetry not required)							
		a			single rear wheels		O	O	NA	NA	NA
		b			dual rear wheels		O	O	R	NA	NA
	3			Stake or Flat Bed							
		a			with storage cabinetry		O	O	O	O	NA
		b			without storage cabinetry		O	O	O	O	NA
3			**Tank**								
	1			Size as required and fill pipe equipped with debris strainer			R	R	R	R	R
	2			Tank material corrosion-resistant to water and foam solution			R	R	R	R	R
	3			Meets NFPA standards for baffling			R	R	R	R	R
	4			Tank venting 1/4 of the area of the larger: inlet or outlet of tank			R	R	R	R	R
4			**Operations**								
	1		Capable of operating all fireline functions when standing on the ground				D	R	R	R	R
	2		Capable of pump and roll attack (80 psi minimum at 2 mph maximum)				R	R	R	R	R
	3		Pressurized source capability								
		a		Fill tank			R	R	R	R	R
		b		Direct to pump at minimum of 125 psi			R	R	R	R	R

Table 3—Criteria for Standard Guidelines for Forest Service Wildland Fire Engines (continued).

5			**Pump**							
	1		Centrifugal pump engine/pump protection engages as pressure							
			drops below 40 psi			O	D	D	R	R
		a		Auxiliary engine shuts down		O	D	R	R	NA
		b		PTO returns engine to idle		NA	NA	NA	R	R
	2		Auxiliary engine equipped with:							
		a		Emission controls		D	D	D	D	NA
		b		Electric starter		O	R	R	R	NA
		c		Spark arrester qualified in accordance with USDA						
					Forest Service Standard 5200-1	R	R	R	R	R
	3		Pump overheat protection for centrifugal pump (coolant line)			R	R	R	R	R
6			**Priming**							
	1		Prime through 24 ft of suction hose with 10 ft lift			R	R	R	R	R
	2		Prime and pump water from a 17 ft lift			D	R	R	R	R
	3		Primer develops 17 inches Hg, no greater than 10 inches loss in 5 min.			D	R	R	R	R
	4		Prime with pump running			D	D	D	D	D
	5		Water or environmentally friendly fluids discharged to ground when priming			R	R	R	R	R
	6		Check valve or equivalent in priming line			R	R	R	R	R
7			**Plumbing**							
	1		Plumbing layout as in "Water Handling Equipment Guide"			O	O	O	O	O
	2		All water flow into pump passes through suction strainer prior to							
				entering pump, strainer can be quickly cleaned		R	R	R	R	R
	3		No humps in suction plumbing			D	D	D	D	D
	4		If humps, priming is from top of hump and also from suction inlet of pump			R	R	R	R	R
	5		Plumbing and pump can be drained and retain a full tank of water			D	D	D	D	D
	6		Minimum required pipe size			R	R	R	R	R
				Pressure piping size (inch)		3/4	1	1 OR 1-1/2	1-1/2	2
				Suction piping size (inch)		3/4	1-1/2	1-1/2	2	3
	7		Overboard suction connection							

Table 3—Criteria for Standard Guidelines for Forest Service Wildland Fire Engines (continued).

	8		Fire hose threads								
				Size	Threads/inch	Nation Bureau of Standards symbol					
				3/4	11-1/2	NH					
				1	11-1/2	NPSH					
				1-1/2	9	NH					
				2	11-1/2	NPSH					
				2-1/2	7-1/2	NH					
				4	7-1/2	NH					
8			**Valves**								
	1			No. 1 Tank to Pump			R	R	R	R	R
	2			No. 2 Pump to Tank			R	R	R	R	R
	3			No. 3 Overboard Discharge			O	R	R	R	R
	4			No. 4 Hose Reel or Basket Discharge			R	R	R	R	R
	5			No. 5 Dedicated Engine Protection Discharge			O	O	O	O	O
	6			No. 6 Pump to Primer (if primer installed)			R	R	R	R	R
	7			No. 7 Pressure Relief Valve, if positive displacement pump installed			R	R	R	R	R
	8			No. 8 Overboard Suction to Pump			R	R	R	R	R
	9			No. 9 Reserve Supply from Tank to Pump			O	O	O	O	O
	10			No. 10 In Tank Shutoff			O	O	O	O	O
	11			No. 11 Pump and Plumbing Drain Valve			D	D	D	D	D
	12			No. 12 Pump Coolant Cleanout			O	O	O	O	O
	13			No. 13 Gravity Tank Drain			O	O	O	O	O
	14			No. 14 Foam Differential Valve Shunt			O	O	O	O	O
	15			No. 15 Pump Transfer Valve			O	O	O	O	O
	16			No. 16 Engine Cooler			O	O	O	O	O
	17			No. 17 Pump Bypass			O	O	O	O	O
	18			No. 18 Low Volume Gravity (backpack fill)			O	O	O	O	O
	19			No. 19 Water only Valve for Eductor Use or water transfer			O	R	R	R	R
	20		Valves 1, 2, 3, 4, 5, 6, 9, 12, 14, 16, 17, 18, & 19, 1/4 turn ball valves				R	R	R	R	R
	21		Valves 8, 10, & 13, 1/4 turn valves				R	R	R	R	R
	22		All visible 1/4 turn valves shall be in the off position when the valve				D	D	D	D	D
				handle is perpendicular to the run of the pipe and in the open							
				position when the valve handle is parallel to the run of the pipe							
	23		Valves of drop out design				D	D	D	D	D
	24		Blind valves labeled open/closed				R	R	R	R	R

Table 3—Criteria for Standard Guidelines for Forest Service Wildland Fire Engines (continued).

	25		Valve functions labeled in clear text and numbers	R	R	R	R	R
	26		Mounted metal operating instruction plate with valve positions for	O	R	R	R	R
			standard fire operations					
	27		All output of pump passes through check valve in pump discharge	R	R	R	R	R
9			**Foam System**					
	1		Foam Proportioner	O	D	D	D	D
		a	Discharge side	R	R	R	R	R
		b	Automatic regulating type	O	O	D	R	R
		c	Accuracy within ± 30 percent	R	R	R	R	R
	2		Capable of downhill foam solution at zero or low pressure while	NA	O	O	O	O
			pumping uphill with foam solution under pressure					
	3		Foam proportioning system will be equipped so foam solution does not	R	R	R	R	R
			return to the main water tank					
10			**Controls and Gauges**					
	1		Gauges					
		a	Discharge pressure gauge	O	R	R	R	R
		b	Pressure gauge is compound or withstand vacuum to 30 inch Hg	R	R	R	R	R
		c	Suction pressure gauge is compound gauge to 30 inch Hg	O	O	D	R	R
		d	Water level indicator	O	D	R	R	R
		e	Gauges freeze protected by a drain near gauges	R	R	R	R	R
	2		Pressure gauge connection at pump discharge prior to check valves	R	R	R	R	R
	3		Variable twist throttle control (on gas/diesel engines)	O	O	R	R	R
	4		Control panel light	O	O	R	R	R
	5		Priming control on panel	O	O	O	R	R
11			**Hose Reel/Hose Basket**	R	R	R	R	R
	1		Electric rewind	D	D	R	R	R
	2		Hose reel equipped with brake	R	R	R	R	R
	3		Hose reel outlet thread—1 inch 11-3/4 NPSH	R	R	R	R	R
12			**Fuel and Fuel Tank**					
	1		Integral units with auxiliary engine-same fuel as chassis	NA	NA	D	D	D
	2		Slip-on units—same fuel as chassis	D	D	D	D	D
	3		Fuel tank with auxiliary engine meets CFR 49					
		a	393.65 prohibits gravity or siphon fuel feed	R	R	R	R	R

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Table 3—Criteria for Standard Guidelines for Forest Service Wildland Fire Engines (continued).

	b		393.67 requires fuel withdrawal fittings for a fuel tank, except	R	R	R	R	R
			for diesel fuel tanks, be above the normal level in the					
			tank when the tank is full					
13			**PTO Integral Unit**					
	1		PTO and pump driveline loadings are within manufacturer's	NA	NA	R	R	R
			recommended maximum operating loadings					
14			**Chassis (for complete unit)***					
	1		Weight of completed vehicle, full of water, with crew members and minimum	R	R	R	R	R
			gear will be less than 90 percent of GVWR					
			Allow 250 lb person per seating position	1–2	1–2	2–3	3–5	3–5
			Minimum miscellaneous gear weight (lb) is:	300	500	1000	1500	2000
	2		Each axle weight when engine fully loaded less than 90 percent of GAWR	R	R	R	R	R
			(Consider equipment distributed evenly throughout the truck body)					
	3		Fully enclosed personnel area	R	R	R	R	R
	4		No platforms provided for personnel to ride outside of personnel area	R	R	R	R	R
	5		Completed vehicle certification	R	R	R	R	R
15			**Storage Cabinetry**	O	O	D	R	R
	1		Dust and water resistant	R	R	R	R	R
	2		Drain in storage cabinetry	D	D	D	D	D
	3		No common walls with water tank	R	R	R	R	R
	4		Storage for long-handled tools and saws	D	D	R	R	R
	5		Storage for suction hose (three pieces of 8 ft long by piping diameter)	O	O	D	R	R
16			**Safety ***					
	1		Safety guard and shields as necessary (CFR 29)	R	R	R	R	R
	2		Backup alarm	R	R	R	R	R
	3		Bumper height meets CFR 49, maximum of 30 inches	R	R	R	R	R
	4		Emergency lights, sirens, and markings meet Forest Service Standards	R	R	R	R	R
17			**Center of Gravity & Angles ***					
	1		Tilt table—30 degrees before lifting front or rear tire. **OR** Height of fully loaded (fire-ready) vehicle, measured at vehicle's center of gravity, must not exceed 75 percent of tread width dimension	R	R	R	R	R
	2		Approach and departure angles greater than 20 degrees	R	R	R	R	R
	3		Fire equipment added does not decrease ramp break over angle	R	R	R	R	R

Table 3—Criteria for Standard Guidelines for Forest Service Wildland Fire Engines (continued).

18			**Written Materials**								
	1		Operating instructions				R	R	R	R	R
	2		Parts manual				R	R	R	R	R
	3		Repair manual				R	R	R	R	R
	4		Fabricator's acceptance inspection and test procedures				R	R	R	R	R
	5		Pump performance label				R	R	R	R	R
	6		Mounting instructions for slip-on units								
		a		Mounting requirements			R	R	R	R	R
		b		Minimum GVWR recommended for slip-on unit			R	R	R	R	R
		c		Minimum GAWR's for truck carrying slip-on unit			R	R	R	R	R
		d		Location of center of gravity of slip-on unit			R	R	R	R	R
19			**Color Integral Unit**								
	1		Color code 14260, green, Federal Standard, FED-STD 595				R	R	R	R	R
		a	When not available the color may only be manufacturer's white				R	R	R	R	R
	2		Vehicle marking and striping shall be in accordance with NFPA 1906								
				and meet Forest Service Standard			R	R	R	R	R
20			**Under GSA Contract**				D	D	D	D	D

* In purchasing slip-on units alone, the purchasing agent is responsible for ensuring these criteria are met. For units that are purchased together as a complete package (truck and slip-on units), the selling agent is responsible for ensuring these criteria are met.

Table 4 defines the criteria as developed by the NWFEC. The table is divided into three columns.

- The first column, Guideline, is a numbering system that coincides with the numbering in the Standard Guidelines. The numbering system also segregates the criteria into section (i.e., tank criteria, operations criteria, pump criteria, etc.).
- The second column, Standard, is the primary reason for the criteria in terms of the fire engines mission, performance of the equipment, maintenance, equipment reliability, economy of operation, safety of operation or operator, and compliance with Federal Requirements or FS Standards.
- The third column, Criteria, provides the definition.

Table 4—Performance and design criteria for Forest Service wildland fire engines.

Guideline	Standard	Criteria
Tank		
3.1	Mission, Performance	Tank size shall be as required to meet minimum gallons for class.
3.1	Maintenance, Performance	Fill pipe for tank shall be equipped with debris strainer to reduce potential for foreign objects damaging pump.
3.2	Maintenance	Tank material shall be corrosion resistant to water and foam solution to prolong the life of the tank and reduce corrosive particles deteriorating valves and plumbing.
3.3	Safety	Tank shall meet National Fire Protection Association (NFPA) standards for baffling to protect personnel from adverse affects in stability and handling due to movement of liquid cargo.
3.4	Performance	Tank shall have adequate venting; 1/4 the area of the inlet or the outlet of the tank whichever is larger to provide adequate replacement of air to prevent a high suction deteriorating pump performance.
Operations		
4.1	Safety	All fireline engine operations shall be performed while standing on the ground. Climbing on or under an apparatus in order to operate controls presents a safety hazard.
4.2	Safety, Performance	The fire engine shall be capable of pump and roll attack (pump minimum of 80 psi at a maximum of 2 mph.) Wildfires in low fuel types and open terrain can be safely and efficiently attacked with an engine that can deliver water while moving.
4.3a	Performance	The fire engine shall be capability of filling tank from a pressurized source. Wildland engines need to be able to access water from hydrants in interface areas. An engine shall have the capability of refilling the tank from any available source.
4.3b	Performance	The fire engine shall be capable of receiving water, through the overboard suction at 125 psi to direct water to the pump for discharge.
Pump		
5.1	Performance, Maintenance	Centrifugal pump engine/pump protection shall engage as pressure drops below 40 psi to reduce the potential of cavitating the pump if the pump is unable to flow water.

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Guideline	Standard	Criteria
5.1a	Performance, Maintenance	Engine protection for the auxiliary engine shall shut it down.
5.1b	Performance, Maintenance	Engine protection for the power take off (PTO) shall return the engine to idle.
5.2a	Environmental	Auxiliary engine shall be equipped with emission controls.
5.2b	Performance	Auxiliary engine shall be equipped with electric starter. This avoids relying on a pull cord starter. Electric start provides faster, more continuous rpm to quickly and easily start the engine. The continuous rpm can prevent engine stalls resulting from flooding or carbon buildup on spark plugs.
5.2c	Safety, FS Standard	Auxiliary engine shall have a spark arrester qualified in accordance with Forest Service Standard 5200-1. Auxiliary engines can throw sparks that could cause fires unless they are equipped with the proper spark arrester.
5.3	Maintenance	A coolant line shall be provided to circulate cool water from the tank to the pump to provide overheating protection of the centrifugal pump and avoid cavitation.
Priming		
6.1	Performance	The engine shall be capable of priming and pumping water through 24 ft of suction hose with10 ft of vertical lift. This criteria establishes a minimum lift capability for the priming system.
6.2	Performance	The engine shall be capable of priming and pumping water through 24 ft of suction hose with 17 ft of vertical lift. This criteria establishes a maximum lift capability for the priming system.
6.3	Performance	The primer shall develop 17 inches of Hg with no greater than a 10-inch loss in 5 minutes. This criteria establishes a minimum vacuum capability for the priming system.
6.4	Performance	The pump shall be capable of being primed with the engine running. In cases where prime may be lost, this allows the operator to safely re-establish a prime without shutting down the engine, reducing the time required to again provide water to the hose lay.
6.5	Mission	Only environmentally safe fluids, water preferred, shall be discharged on the ground when priming. This is to avoid contaminating the environment with the oil that some primers use. Water-only discharge primers eliminate primer servicing and associated equipment.
6.6	Performance	The priming line shall have a check valve or equivalent.
Plumbing		
7.1	Performance	Plumbing layout shall be as described in the “Water Handling Equipment Guide.”
7.2	Maintenance	All water flow shall pass through a suction strainer prior to entering the pump to avoid debris entering and damaging the pump. It must be easily accessible in order to be cleaned.

Guideline	Standard	Criteria
7.3	Performance	The suction plumbing section should not have "humps." Suction plumbing that has humps retain air bubbles after a prime is established and pumping has started. These bubbles can be drawn into the pump, causing a loss of prime.
7.4	Safety	If there are humps in the suction plumbing, priming taps at both the top of the hump and the inlet of the pump shall be used. Without priming taps at top of the hump, priming may be slow or impossible.
7.5	Maintenance	The entire plumbing system and pump shall be capable of being drained without emptying the tank. This allows for winterization of the system.
7.6	Performance, Economy	The piping size shall match the designed engine discharge performance. If the piping, particularly the suction but also the pressure piping, are too small, the performance of the engine will be degraded. Too large of piping is costly and adds unnecessary weight.
7.7	Mission	Newly purchased fire engines must have the proper connections so they will match the existing equipment (hoses, etc.) that have been standardized in the FS fire caches. This avoids the need for adapters and provides for interchangeability.
7.8	FS Standard	Fire hose connections on engines shall have these threads: 3/4-inch, 1-1/2 inch, 2-1/2, and 4 inch are NH, and 1and 2 inch are NPSH. Newly purchased fire engines must have the proper connections so they will match the existing equipment (hoses, etc.) that have been standardized in the FS fire caches. This avoids the need for adapters and provides for interchangeability.
Valves		
8	FS Standard, Performance	The following valve nomenclature shall be used on Forest Service Wildland Fire Engines.
8.1	FS Standard, Performance	Valve No. 1, Tank to Pump, allows the isolation of the tank and allows for drafting.
8.2	FS Standard, Performance	Valve No. 2, Pump to Tank, allows for refilling of the tank through the plumbing, without using external hoses. Allows for refilling of the tank while pumping a hose lay.
8.3	FS Standard, Performance	Valve No. 3, Overboard Discharge, allows control of the output of the pump or isolating hose lays.
8.4	FS Standard, Performance	Valve No. 4, Hose Reel or Basket Discharge, allows for isolation of the hose reel or basket discharge.
8.5	FS Standard	Valve No. 5, Dedicated Engine Protection Discharge, no longer in wide use.
8.6	FS Standard	Valve No. 6, Pump to Primer, allows for isolation of the primer. In cases of filling the tank from a pressurized source, it will stop water from being discharged out through the primer.
8.7	Safety	Valve No. 7, Pressure Relief Valve for positive displacement pumps, protects the equipment from over pressurizing the pump.
8.8	FS Standard, Mission	Valve No. 8, Overboard Suction, controls pump intake from draft or pressurized source.

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Guideline	Standard	Criteria
8.9	FS Standard	Valve No. 9, Reserve Supply from Tank to Pump, no longer in wide use. Provides for a reserve amount of water in the tank.
8.10	FS Standard	Valve No. 10, In Tank Shutoff, no longer in wide use.
8.11	FS Standard, Maintenance	Valve No. 11, Pump and Plumbing Drain Valve, provides quick winterization and maintenance of plumbing.
8.12	FS Standard	Valve No. 12, Pump Coolant or Filter Cleanout, allows for cleaning pump coolant line filter.
8.13	FS Standard	Valve No. 13, Gravity Tank Drain, allows for draining the tank.
8.14	FS Standard	Valve No. 14, Foam Differential Valve Shunt, provides an alternate flow path around the proportioner to the overboard discharge. Some flow through the proportioner will still occur.
8.15	FS Standard	Valve No. 15, Pump Transfer Valve, used on specific pumps. Changes the pump from flowing greater volume to greater pressure or vice versa.
8.16	FS Standard	Valve No. 16, Engine Cooler, no longer in wide use.
8.17	FS Standard	Valve No. 17, Pump Cooling Line Bypass, controls waterflow from the discharge side of the pump to the inlet side through the pump cooling line.
8.18	FS Standard	Valve No. 18, Low Volume Gravity, used for filling backpack pumps.
8.19	Performance, Mission	Valve No. 19, Water Only Valve, the engine shall have a clean water only discharge connection if equipped with a foam system. When filling the tank of another engine or using an eductor, clean water is required. Environmentally sensitive areas must have clean water discharge.
8.20	Maintenance, Performance	All major operating valves shall be one-quarter-turn ball valves. Ball valves are quick and easy to operate. It is easy to determine if a one-quarter-turn ball valve is open or closed. In addition, if all of the valves are the same type, this facilitates training and proper operation of the fire engine.
8.21	Performance	Valves 8, 10, and 13 shall be one-quarter-turn valves. One-quarter-turn valves provide quick visual indication when the valves open or closed and they are quick to operate.
8.24	Performance	Blind valves shall be labeled open and closed. The position of the operating handle must indicate the valve status.
8.25	Performance	Function of the valves shall be labeled in clear text and numbers to facilitate training and performance by different operators.
8.26	Performance	A metal operating instruction plate with valve positions shall be mounted near the operator's panel to facilitate training and performance by different operators.
8.27	Performance, Reliability	A check valve(s) shall be placed on the discharge side of the pump such that all pump flow passes through it prior to any branching. This check valve(s) prevents backflow of water and foam into the tank, pump, or water source. It also prevents loss of prime and stops pressurization of the suction hose if the pump stops.

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Guideline	Standard	Criteria
Foam System		
9.1a	Performance	If equipped with a foam proportioner, it shall be plumbed on the discharge side. This keeps foam from entering the tank and pump, which reduces maintenance and the need to flush foam from the pump.
9.1b	Performance	If equipped with a foam proportioner, an automatic regulating type shall be used. Automatic regulating type proportioners maintain more accurate proportions over a wider range of flows without adjustment. Engines need to be able to vary the percentage of foam to adapt to different fuel types. Over the life of the engine, automatic regulating proportioners have a cost advantage over manually regulated systems because they control the amount of foam used so none is wasted. (See appendix A, Foam System or Foam Proportioning Equipment.)
9.1c	Economy	If equipped with a foam proportioner, it shall be capable of controlling the foam concentration within ± 30 percent.
9.2	Performance.	If equipped with a foam proportioner, the fire package shall be capable of providing foam solution simultaneously to both uphill and downhill hose lays, without creating an overpressure hazard to the downhill hose lay.
9.3	Maintenance, Performance	If equipped with a foam system, the plumbing and check valves shall be arranged so foam does not return to the main water tank. Foam is corrosive and can harm metal components. Once it is in the tank and plumbing it is difficult and time consuming to get out. Foam in the tank can also cause problems for the pump (i.e., lose prime).
Controls and Gauges		
10.1a	Safety, Performance	Engine shall have a discharge pressure gauge on the discharge side of the pump. The operator must be able to know actual pump pressure to deliver adequate water to the nozzle and recognize problems such as loss of prime or break in the hose lay.
10.1b	Performance	The pressure gauge shall be compound or withstand vacuum to 30 inches of Hg. This criteria provides a minimum performance for the pump discharge gauge.
10.1c	Performance	The suction pressure gauge shall be a compound gauge to 30 inches of Hg. The operator needs an accurate gauge to monitor incoming pressure from a pressurized source to ensure it does not exceed recommended maximum pressure and damage the pump.
10.1d	Safety, Performance	The fire engine shall have a water level indicator. The operator must have a visual indicator near the control of the amount of water in the tank panel in order to continue to deliver adequate water to the nozzle.
10.1e	Maintenance	Gauges shall be freeze protected by a drain near the valve. FS engines are exposed to freezing conditions.

Guideline	Standard	Criteria
10.2	Performance	A discharge pressure gauge shall be provided and connected between the pump and the check valve. It must be attached between the pump and check valve because this is the only place where real time output of the pump can be measured. If the pump has an output check valve and a continuous bleed line after the check valve, the pressure gauge can be connected after the output check valve.
10.3	Performance	Engines shall have a variable twist throttle control on gas and diesel engines for operator ease in adjusting pump pressure.
10.4	Safety	Engines shall have a control panel light for night operations.
10.5	Performance	The priming control shall be mounted on or near the control panel to allow the operator to monitor the gauges, draft hose, and throttle when priming.
Hose Reel/ Hose Basket		
11.	Safety, Performance	Engines shall have a hose reel or hose basket for one of the discharge lines. This is a preconnected charged line for initial attack and engine protection.
11.1	Safety, Performance	Engines shall have an electric rewind on the hose reel to retrieve hose quickly, to change position of engine, and remain mobile.
11.2	Safety	Engine hose reels shall be equipped with a brake.
11.3	FS Standard	Hose reel outlet thread shall be 1 inch NPSH 11-3/4 threads. Newly purchased fire engines must have the proper connections so they will match the existing equipment (hoses, etc.) that have been standardized in the FS fire caches. This avoids the need for adapters and provides for interchangeability.
Fuel and Fuel Tank		
12.1	Economy	Integral fire engines equipped with auxiliary engines shall use the same type of fuel.
12.2	Economy	Slip-on fire packages shall be matched with a chassis that uses the same fuel type as the slip-on.
12.3 a & b	Safety, Federal Requirement	If equipped with an auxiliary engine, the fuel tank and fitting shall meet CFR 49 (393.65 prohibits gravity or siphon feed, and 393.67 requires gasoline withdrawal fittings in fuel tank to be above the fuel level when tank is full). The intent of these regulations is to prevent fuel spills that can be serious safety hazards. If these regulations are not followed and a fuel line is broken or becomes disconnected, fuel can run out of the tank.
PTO Integral Unit		
13.1	Safety, Reliability, Economy	PTO and pump driveline loadings shall be within manufacturer recommended maximums. If the manufacturer guidelines are exceeded (for instance, if the maximum for intermittent use rather than continuous use is chosen for the design) the reliability and life of the equipment will be degraded. Failure of the pump driveline in excess of maximum load may lead to injury.

Guideline	Standard	Criteria
Chassis		
14.1	Safety (FSM 7130 Guideline)	The fire-ready engine with crew shall weigh less than 90 percent of the truck's GVWR. Trucks that exceed the manufacturer's GVWR are not safe. A completely equipped (fire-ready) engine must not exceed 90 percent of the chassis manufacturer's GVWR. In addition, vehicles over 90 percent of GVWR are subject to high maintenance costs.
14.2	Safety (FSM 7130 Guideline)	The fire-ready engine with crew shall be balanced such that each axle is loaded less than 90 percent of the respective gross axle weight rating (GAWR). Trucks that exceed the manufacturer's GAWR are not safe. A completely equipped (fire-ready) engine must not exceed 90 percent of the chassis manufacturer's GAWR. In addition, vehicles over 90 percent of GAWR are subject to high maintenance costs.
14.3	Safety	The personnel area shall be fully enclosed. FS wildland engines travel long distances in varying weather conditions, day and night. During operational conditions an enclosed cab offers respite from fireline conditions.
14.4	Safety	No platforms shall be provided for personnel to ride outside. Personnel shall be protected. Riding outside is unsafe.
14.5	Safety. Federal Requirement	A completed vehicle certification shall be required per CFR 49 (Part 567—Certification). The final stage manufacturer must affix a permanent certification label or tag certifying that the unit meets all required federal safety standards pertaining to the manufacture and completion of the fire apparatus.
Storage Cabinetry		
15	Performance	Engines shall have storage cabinetry. Equipment and personnel gear must be stored securely and out of the elements.
15.1	Maintenance	Cabinetry shall be sealed for dust and water resistance. Equipment and personnel gear needs protection from dust and water in fireline conditions.
15.2	Maintenance	Cabinetry shall have drains to allow water to drain away. This will help reduce corrosion.
15.3	Safety	Storage cabinetry shall have no walls in common with the water tank. This reduces potential to have condensation in storage compartments and reduces the potential to compromise the integrity of the tank.
15.4	Safety	Engines shall have storage cabinetry for long-handled tools and saws. Dimensions of the storage compartments must accommodate equipment used on the fireline and keep them secure and serviceable.
15.5	Performance	Engines shall have storage for three lengths of 8 ft suction hose matched to piping diameter. Dimensions of the storage compartments must accommodate equipment used to draft and keep them secure and serviceable.

Guideline	Standard	Criteria
Safety		
16.1	Safety	Safety guards and shields shall be provided in accordance with CFR 29. Title 29 regulations relate to labor and are issued by the Occupational Safety and Health Administration (OSHA). These regulations must be followed for the safety of personnel.
16.2	Safety	Engines shall be equipped with backup alarm. This safety measure is to warn personnel of the movement of the apparatus.
16.3	Safety, Federal Requirement	The bumper or extension shall be no higher than 30 inches to conform to CFR 49 (393.86). The purpose of this regulation is to prevent low vehicles from running up under larger (taller) vehicles.
16.4	Safety, Forest Service Policy	If the use of emergency lights and sirens are approved, they shall meet FS Standards.
Center of Gravity and Angles		
17.1	Safety	Vehicle stability shall meet one of the following: a) the height of a fully loaded (fire-ready) vehicle, measured at the vehicle's center of gravity, must not exceed 75 percent of the tread width dimension, or b) the vehicle must exceed 30 degree angle on tilt table before wheel lift. Unstable vehicles are not safe. Either method gives a good indication of the stability of a vehicle.
17.2	Safety	Approach and departure angles shall be greater than 20 degrees. This is a minimum measurable criteria for engine operations in steep terrain.
17.3	Safety	Ramp break over angle shall not be decreased by the addition of the fire package. This is a minimum measurable criteria for engine operations in steep terrain.
Written Materials		
18.1	Safety, Performance	Written operating instructions shall be provided. It is essential that the operators fully understand the complete capabilities, limitations, and safety aspects of a fire engine. It is the responsibility of the manufacturer to provide this information.
18.2	Maintenance	The fire engine shall have a parts manual. This allows fleet inspectors to properly order parts from the field.
18.3	Maintenance	The engines shall have a repair manual. This allows fleet inspectors to effect repairs in the field.
18.4	Safety, Performance	Fire engine final inspection and performance results shall be provided. For each completed unit, the manufacturer will provide test results on all electrical and pumping systems, and the empty weight of the vehicle. Pump performance as determined by NFPA 1906 pump test procedure will be documented and affixed to the engine in the vicinity of the operator's panel. The weight of the vehicle shall include the weight of each axle separately.

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Guideline	Standard	Criteria
18.5	Safety, Performance	A pump performance label shall be mounted near the control panel to provide performance monitoring and check standards.
18.6 a	Safety, Performance	Slip-on units shall include mounting instructions. This will help ensure safe and secure placement of the unit.
18.6 b	Safety	Minimum GVWR requirements for slip-on units shall be included with final package. This will ensure unit is mounted on a platform rated to handle its capacity with its fire equipment.
18.6 c	Safety	Minimum GAWR requirements for truck carrying slip-on shall be in written recommendations. This will ensure unit is mounted on a platform rated to handle its capacity with its fire equipment.
18.6 d	Safety	The center of gravity of the fully loaded slip-on unit will be written in final package. This will determine bed placement of the slip-on unit
Color		
19.1	FS Standard	Engines shall be green, color code 14260, Federal Standard, FED-STD 595.
19.a	FS Standard	If the green is not available, engines shall be the manufacturer's white.
19.2	FS Standard	Engine markings and striping shall be in accordance with NFPA 1906 and FS Standards.

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CLASS LP WILDLAND FIRE ENGINE EVALUATION RESULTS

			Required		
				Engine Class	**LP**
				Equipment Designator	MB58-PO
1				**Engine Characteristics (Engine Capability)**	
	1			Required Pump Flow	Rated/Actual
		a		GPM (minimum) 8	13/9
		b		@pressure (psi) 65	150/150
	2			Required Tank Size	
		a		minimum (gal) 50	58
		b		actual (gal)	32
	3			Crew Seats 1–2	n/a
2				**Engine Configuration**	n/a
	1			Integral Units (with storage cabinetry)	n/a
		a		PTO	n/a
		b		Auxiliary Engine	n/a
	2			Slip-on Units	n/a
				Pickup or Utility Body (storage cabinetry not required)	n/a
		a		single rear wheels	n/a
		b		dual rear wheels	n/a
	3			Stake or Flat Bed	n/a
		a		with storage cabinetry	n/a
		b		without storage cabinetry	n/a
3				**Tank**	
	1		**R**	Size as required and fill pipe equipped with debris strainer	no/yes
	2		**R**	Tank material corrosion-resistant to water and foam solution	yes
	3		**R**	Meets NFPA standards for baffling	n/a
	4		**R**	Tank venting 1/4 of the area of the larger: inlet or outlet of tank	no
4				**Operations**	
	1			Capable of operating all fireline functions when standing on the ground	yes
	2		**R**	Capable of pump and roll attack (80 psi minimum at 2 mph maximum)	yes
	3			Pressurized source capability	
		a	**R**	Fill tank	no
		b	**R**	Direct to pump at minimum of 125 psi	no
5				**Pump**	
	1			Centrifugal pump engine/pump protection engages as pressure drops below 40 psi	n/a
		a		Auxiliary engine shuts down	n/a
		b		PTO returns engine to idle	n/a
	2			Auxiliary engine equipped with:	
		a		Emission controls	no
		b		Electric starter	no
		c	**R**	Spark arrester qualified in accordance with USDA Forest Service Standard 5200-1	no
	3		**R**	Pump overheat protection for centrifugal pump (coolant line)	n/a

CLASS LP WILDLAND FIRE ENGINE EVALUATION RESULTS

6				**Priming**				
	1		**R**	Prime through 24 ft of suction hose with 10 ft lift				7 s
	2			Prime and pump water through 24 ft of suction hose with 17 ft lift				12 s
	3			Primer develops 17 inches/Hg, no greater than a 10 inch loss in 5 min.				25.5 inches/Hg
	4			Prime with pump running				yes
	5		**R**	Water or environmentally friendly fluids discharged to ground when priming				yes
	6		**R**	Check valve or equivalent in priming line				n/a
7				**Plumbing**				
	1			Plumbing layout as in "Water Handling Equipment Guide"				no
	2		**R**	All water flow into pump passes through suction strainer prior to entering pump, strainer can be quickly cleaned				yes
	3			Humps in suction plumbing				yes
	4			If humps in suction plumbing priming is from top of hump and pump				n/a
	5			Plumbing and pump can be drained and retain a full tank of water				no
	6		**R**	Minimum required pipe size				
				Pressure piping size (inch)				1
				Suction piping size (inch)				1 1/4
	7		**R**	Overboard suction connection (inch)				1
	8		**R**	Fire hose threads				
					Size	Threads/inch	National Bureau of Standards symbol	
					3/4	11-1/2	NH	
					1	11-1/2	NPSH	yes
					1-1/2	9	NH	
					2	11-1/2	NPSH	
					2-1/2	7-1/2	NH	
					4	7-1/2	NH	
8				**Valves**				
	1		**R**	No. 1 Tank to Pump				yes
	2		**R**	No. 2 Pump to Tank				no
	3			No. 3 Overboard Discharge				no
	4		**R**	No. 4 Hose Reel or Basket Discharge				no
	5			No. 5 Dedicated Engine Protection Discharge				no
	6		**R**	No. 6 Pump to Primer (if primer installed)				n/a
	7		**R**	No. 7 Pressure Relief Valve, if positive displacement pump installed				yes
	8		**R**	No. 8 Overboard Suction to Pump				yes
	9			No. 9 Reserve Supply from Tank to Pump				no
	10			No. 10 In Tank Shutoff				no
	11			No. 11 Pump and Plumbing Drain Valve				no
	12			No. 12 Pump Coolant Cleanout				no
	13			No. 13 Gravity Tank Drain				yes
	14			No. 14 Foam Differential Valve Shunt				no
	15			No. 15 Pump Transfer Valve				no
	16			No. 16 Engine Cooler				no
	17			No. 17 Pump Bypass				no

	18			No. 18 Low Volume Gravity (backpack fill)	no
	19			No. 19 Water only Valve for Eductor Use or water transfer	no
	20		**R**	Valves 1, 2, 3, 4, 5, 6, 9, 12, 14, 16, 17, 18, & 19, 1/4-turn ball valves	yes
	21		**R**	Valves 8, 10, & 13, 1/4-turn valves	yes
	22			All visible 1/4-turn valves shall be in the off position when the valve handle is perpendicular to the run of the pipe and in the open position when the valve handle is parallel to the run of the pipe	n/a
	23			Valves of drop out design	no
	24		**R**	Blind valves labeled open/closed	no
	25		**R**	Valve functions labeled in clear text and numbers	no
	26			Mounted metal operating instruction plate with valve positions for standard fire operations	no
	27		**R**	All output of pump passes through check valve in pump discharge	no
9				**Foam System**	
	1			Foam Proportioner	yes
		a	**R**	Discharge side	no
		b		Automatic regulating type	no
		c	**R**	Accurate within ± 30 percent	no
	2			Capable of downhill foam solution at zero or low pressure while pumping uphill with foam solution under pressure	no
	3		**R**	Foam proportioning system installed so foam solution does not return to the main water tank	yes
10				**Controls and Gauges**	
	1			Gauges	none
		a		Discharge pressure gauge	
		b	**R**	Pressure gauge is compound or withstand vacuum to 30 inches/Hg	
		c		Suction pressure gauge (compound gauge to 30 inches/Hg)	
		d		Water level indicator	
		e	**R**	Gauges freeze protected/by a drain near gauges	
	2		**R**	Pressure gauge connection at pump discharge prior to check valves	
	3			Variable twist throttle control (on gas/diesel engines)	
	4			Control panel light	
	5			Priming control on panel	
11			**R**	**Hose Reel/Hose Basket**	none
	1			Electric rewind	
	2		**R**	Hose reel equipped with brake	
	3		**R**	Hose reel outlet thread—1 inch 11-3/4 NPSH	
12				**Fuel and Fuel Tank**	unleaded
	1			Integral units with auxiliary engine-same fuel as chassis	
	2			Slip-on units—same fuel as chassis	
	3			Fuel tank with auxiliary engine meets CFR 49	
		a	**R**	393.65 prohibits gravity or siphon fuel feed	no

		b	**R**	393.67 requires fuel withdrawal fittings for a fuel tank, except for diesel fuel tanks, be above the normal level in the tank when the tank is full	no
13				**PTO Integral Unit**	n/a
	1		**R**	PTO and pump driveline loadings are within manufacturer's recommended maximum operating loadings	
14				**Chassis (for complete unit)**	
	1		**R**	Weight of completed vehicle, full of water, with crew members and minimum gear will be less than 90 percent of GVWR Allow 250 lb/person per seating position Minimum miscellaneous gear weight (lb) is:	
	2		**R**	Each axle weight when engine fully loaded less than 90 percent of GAWR (Consider equipment distributed evenly throughout the truck body)	
	3		**R**	Fully enclosed personnel area	
	4		**R**	Platforms provided for personnel to ride outside of personnel area	
	5		**R**	Completed Vehicle Certification	
15				**Storage Cabinetry**	n/a
	1		**R**	Dust and water resistant	
	2			Drain in storage cabinetry	
	3		**R**	Common walls with water tank	
	4			Storage for long-handle tools and saw	
	5			Storage for suction hose (three pieces of 8 ft long by piping diameter)	
16				**Safety**	n/a
	1		**R**	Safety Guard and Shields as necessary (CFR 29)	
	2		**R**	Back-up alarm	
	3		**R**	Bumper height meets CFR 49 393.86 (30 inches)	
	4		**R**	Emergency lights, sirens, and markings meet Forest Service policy	
17				**Center of Gravity and Angles**	n/a
	1		**R**	Tilt table 30 degrees before lifting front or rear tire **OR** Height of fully loaded (fire-ready) vehicle, measured at vehicle's center of gravity, must not exceed 75 percent of tread width dimension	
	2		**R**	Approach and departure angles greater than 20 degrees	
	3		**R**	Fire equipment decreases ramp break-over angle	
18				**Written Materials**	
	1		**R**	Operating instructions	yes
	2		**R**	Parts manual	yes
	3		**R**	Repair manual	yes
	4		**R**	Fabricator's acceptance inspection and test procedures	yes
	5		**R**	Pump performance label	yes
	6			Mounting instructions for slip-on units	suggestions
		a	**R**	Mounting requirements	no
		b	**R**	Minimum GVWR recommended for slip-on unit	no
		c	**R**	Minimum GAWR for truck carrying slip-on unit	no
		d	**R**	Location of center of gravity of slip-on unit	no

19				**Color Integral Unit**	
	1		**R**	Color code 14260, green, Federal Standard, FED-STD 595	yes
		a		When not available the color may only be manufacturer's white	
	2			Vehicle marking & striping and shall be in accordance with NFPA 1906	
				and meet Forest Service standard	
20				**Under GSA Contract**	yes
21				**Cost Slip-on Unit**	$5,884
22				**Cost Fire Package and Chassis**	

CLASS A WILDLAND FIRE ENGINE EVALUATION RESULTS

			Required		
				Engine Class	**A**
				Equipment Designator	Robwen Model 180
1				**Engine Characteristics (Engine Capability)**	
	1			Required Pump Flow	Rated/Actual
		a		GPM (minimum) 20	50/52
		b		@pressure (psi) 100	200
	2			Required Tank Size	
		a		minimum (gal) 50	200
		b		actual (gal)	96
	3			Crew Seats 1–2	2–3
2				**Engine Configuration**	
	1			Integral Units (with storage cabinetry)	
		a		PTO	n/a
		b		Auxiliary Engine	n/a
	2			Slip-on Units	
				Pickup or Utility Body (storage cabinetry not required)	
		a		single rear wheels	yes
		b		dual rear wheels	n/a
	3			Stake or Flat Bed	
		a		with storage cabinetry	n/a
		b		without storage cabinetry	n/a
3				**Tank**	
	1		**R**	Size as required and fill pipe equipped with debris strainer	yes
	2		**R**	Tank material corrosion-resistant to water and foam solution	yes
	3		**R**	Meets NFPA standards for baffling	yes
	4		**R**	Tank venting 1/4 of the area of the larger: inlet or outlet of tank	yes
4				**Operations**	
	1		**R**	Capable of operating all fireline functions when standing on the ground	no
	2		**R**	Capable of pump and roll attack (80 psi minimum at 2 mph maximum)	yes
	3			Pressurized source capability	yes
		a	**R**	Fill tank	yes
		b	**R**	Direct to pump at minimum of 125 psi	yes
5				**Pump**	
	1			Centrifugal pump engine/pump protection engages as pressure	
				drops below 40 psi	yes
		a		Auxiliary engine shuts down	yes
		b		PTO returns engine to idle	n/a
	2			Auxiliary engine equipped with:	
		a		Emission controls	no info
		b	**R**	Electric starter	yes
		c	**R**	Spark arrester qualified in accordance with USDA	
				Forest Service Standard 5200-1	yes
	3		**R**	Pump overheat protection for centrifugal pump (coolant line)	yes

6				**Priming**				
	1		**R**	Prime through 24 ft of suction hose with 10 ft lift				22 s
	2		**R**	Prime and pump water through 24 ft of suction hose with 17 ft lift				46 s
	3		**R**	Primer develops 17 inches/Hg, no greater than a 10 inch loss in 5 min.				20 inches/Hg
	4			Prime with pump running				yes
	5		**R**	Water or environmentally friendly fluids discharged to ground when priming				yes
	6		**R**	Check valve or equivalent in priming line				yes
7				**Plumbing**				
	1			Plumbing layout as in "Water Handling Equipment Guide"				yes
	2		**R**	All water flow into pump passes through suction strainer prior to entering pump, strainer can be quickly cleaned				yes/yes
	3			Humps in suction plumbing				no
	4		**R**	If humps in suction plumbing priming is from top of hump and pump				n/a
	5			Plumbing and pump can be drained and retain a full tank of water				no
	6		**R**	Minimum required pipe size				yes
				Pressure piping size (inch)				1-1/2
				Suction piping size (inch)				1-1/2
	7		**R**	Overboard suction connection				yes
	8		**R**	Fire hose threads				yes
					Size	Threads/inch	National Bureau of Standards symbol	
					3/4	11-1/2	NH	yes
					1	11-1/2	NPSH	yes
					1-1/2	9	NH	yes
					2	11-1/2	NPSH	yes
					2-1/2	7-1/2	NH	yes
					4	7-1/2	NH	yes
8				**Valves**				
	1		**R**	No. 1 Tank to Pump				yes
	2		**R**	No. 2 Pump to Tank				yes
	3		**R**	No. 3 Overboard Discharge				yes
	4		**R**	No. 4 Hose Reel or Basket Discharge				yes
	5			No. 5 Dedicated Engine Protection Discharge				no
	6		**R**	No. 6 Pump to Primer (if primer installed)				yes
	7		**R**	No. 7 Pressure Relief Valve, if positive displacement pump installed				n/a
	8		**R**	No. 8 Overboard Suction to Pump				yes
	9			No. 9 Reserve Supply from Tank to Pump				no
	10			No. 10 In Tank Shut-off				no
	11			No. 11 Pump and Plumbing Drain Valve				yes
	12			No. 12 Pump Coolant Clean-out				no
	13			No. 13 Gravity Tank Drain				no
	14			No. 14 Foam-Differential-Valve Shunt				no
	15			No. 15 Pump Transfer Valve				n/a
	16			No. 16 Engine Cooler				n/a
	17			No. 17 Pump Bypass				no
	18			No. 18 Low Volume Gravity (backpack fill)				no

	19		R	No. 19 Water only Valve for Eductor Use or water transfer	no
	20		R	Valves 1, 2, 3, 4, 5, 6, 9, 12, 14, 16, 17, 18, & 19, 1/4-turn ball valves	yes
	21		R	Valves 8, 10, & 13, 1/4-turn valves	yes
	22			All visible 1/4-turn valves shall be in the off position when the valve handle is perpendicular to the run of the pipe and in the open position when the valve handle is parallel to the run of the pipe	yes
	23			Valves of drop out design	no optional
	24		R	Blind valves labeled open/closed	yes
	25		R	Valve functions labeled in clear text and numbers	yes
	26		R	Mounted metal operating instruction plate with valve positions for standard fire operations	no
	27		R	All output of pump passes through check valve in pump discharge	yes
9				**Foam System**	
	1			Foam Proportioner	yes
		a	R	Discharge side	yes
		b		Automatic regulating type	yes
		c	R	Accurate within ± 30 percent	no
	2			Capable of downhill foam solution at zero or low pressure while pumping uphill with foam solution under pressure	no
	3		R	Foam proportioning system installed so foam solution does not return to the main water tank	yes
10				**Controls and Gauges**	
	1			Gauges	
		a	R	Discharge pressure gauge	yes
		b	R	Pressure gauge is compound or withstand vacuum to 30 inches/Hg	yes
		c		Suction pressure gauge (compound gauge to 30 inches/Hg)	no
		d		Water level indicator	yes
		e	R	Gauges freeze protected/by a drain near gauges	no/no
	2		R	Pressure gauge connection at pump discharge prior to check valves	yes
	3			Variable twist throttle control (on gas/diesel engines)	yes
	4			Control panel light	yes
	5			Priming control on panel	yes
11			R	**Hose Reel/Hose Basket**	hose reel
	1			Electric rewind	yes
	2		R	Hose reel equipped with brake	yes
	3		R	Hose reel outlet thread—1 inch 11-3/4 NPSH	yes
12				**Fuel and Fuel Tank**	
	1			Integral units with auxiliary engine-same fuel as chassis	n/a
	2			Slip-on units—same fuel as chassis	gasoline
	3			Fuel tank with auxiliary engine meets CFR 49	
		a	R	393.65 prohibits gravity or siphon fuel feed	no

		b	**R**	393.67 requires fuel withdrawal fittings for a fuel tank, except for diesel fuel tanks, be above the normal level in the tank when the tank is full	no
13				**PTO Integral Unit**	
	1		**R**	PTO and pump driveline loadings are within manufacturer's recommended maximum operating loadings	n/a
14				**Chassis (for complete unit)**	
	1		**R**	Weight of completed vehicle, full of water, with crew members and minimum gear will be less than 90 percent of GVWR	n/a
				Allow 250 lb/person per seating position	n/a
				Minimum miscellaneous gear weight (lb) is:	n/a
	2		**R**	Each axle weight when engine fully loaded less than 90 percent of GAWR	
				(Consider equipment distributed evenly throughout the truck body)	n/a
	3		**R**	Fully enclosed personnel area	n/a
	4		**R**	Platforms provided for personnel to ride outside of personnel area	n/a
	5		**R**	Completed Vehicle Certification	n/a
15				**Storage Cabinetry**	n/a
	1		**R**	Dust and water resistant	n/a
	2			Drain in storage cabinetry	n/a
	3		**R**	Common walls with water tank	n/a
	4			Storage for long-handle tools and saw	n/a
	5			Storage for suction hose (three pieces of 8 ft long by piping diameter)	no
16				**Safety**	
	1		**R**	Safety Guard and Shields as necessary (CFR 29)	yes
	2		**R**	Back-up alarm	n/a
	3		**R**	Bumper height meets CFR 49 393.86 (30 inches)	n/a
	4		**R**	Emergency lights, sirens, and markings meet Forest Service Policy	n/a
17				**Center of Gravity and Angles**	
	1		**R**	Tilt table 30 degrees before lifting front or rear tire **OR** Height of fully loaded (fire-ready) vehicle, measured at the vehicle's center of gravity, must not exceed 75 percent of tread width dimension	n/a
	2		**R**	Approach and departure angles greater than 20 degrees	n/a
	3		**R**	Fire equipment decreases ramp break over angle	n/a
18				**Written Materials**	
	1		**R**	Operating instructions	no
	2		**R**	Parts manual	no
	3		**R**	Repair manual	no
	4		**R**	Fabricator's acceptance inspection and test procedures	no
	5		**R**	Pump performance label	no
	6			Mounting instructions for slip-on units	
		a	**R**	Mounting requirements	no
		b	**R**	Minimum GVWR recommended for slip-on unit	no
		c	**R**	Minimum GAWR for truck carrying slip-on unit	no
		d	**R**	Location of center of gravity of slip-on unit	27 front

CLASS A WILDLAND FIRE ENGINE EVALUATION RESULTS

19				**Color Integral Unit**	
	1		**R**	Color code 14260, green, Federal Standard, FED-STD 595	yes
		a		When not available the color may only be manufacturer's white	
	2			Vehicle marking & striping and shall be in accordance with NFPA 1906	
				and meet Forest Service Standard	
20				**Under GSA Contract**	yes
21				**Cost Slip-on Unit**	$10,000
22				**Cost Fire Package and Chassis**	

			Required							
				Engine Class		B	B	B	B	B
				Equipment Designator		Wildfire Pacific Slip-On	R-4 Model 52 4x4	R-4 Model 52 4x4	R-6 Model 30	R-6 Model 45
1				**Engine Characteristics (Engine Capability)**						
	1			Required Pump Flow		Rated/Actual	Rated/Actual	Rated/Actual	Rated/Actual	Rated/Actual
		a		GPM (minimum)	50	80/74	80/54	32/35	80/72	70/78
		b		@pressure (psi)	200	200	200	350	200	200
	2			Required Tank Size						
		a		minimum (gal)	50	200	200	200	200	200
		b		actual (gal)		235	290	619	262	312
	3			Crew Seats	2–3	2–3	3	3	3	3
2				**Engine Configuration**						
	1			Integral Units (with storage cabinetry)						
		a		PTO		n/a	n/a	n/a	n/a	yes
		b		Auxiliary Engine		n/a	n/a	n/a	n/a	n/a
	2			Slip-on Units						
				Pickup or Utility Body (storage cabinetry not required)						
		a		single rear wheels		n/a	n/a	n/a	n/a	n/a
		b	R	dual rear wheels		yes	yes	yes	yes	n/a
	3			Stake or Flat Bed						
		a		with storage cabinetry		n/a	yes	yes	n/a	n/a
		b		without storage cabinetry		yes	n/a	n/a	n/a	n/a
3				**Tank**						
	1		R	Size as required and fill pipe equipped with debris strainer		yes	yes	yes	yes/yes	yes/yes
	2		R	Tank material corrosion-resistant to water and foam solution		yes	yes	yes	yes	yes
	3		R	Meets NFPA standards for baffling		yes	yes	yes	yes	yes
	4		R	Tank venting 1/4 of the area of the larger: inlet or outlet of tank		yes	yes	yes	yes	no info
4				**Operations**						
	1		R	Capable of operating all fireline functions when standing on the ground		no	yes	yes	yes	yes
	2		R	Capable of pump and roll attack (80 psi minimum at 2 mph maximum)		yes	yes	yes	yes	no info
	3			Pressurized source capability						
		a	R	Fill tank		yes	yes	yes	yes	yes
		b	R	Direct to pump at minimum of 125 psi		yes	yes	yes	yes	yes
5				**Pump**						
	1	R		Centrifugal pump engine/pump protection engages as pressure drops below 40 psi		yes	yes	yes	yes	no info
		a		Auxiliary engine shuts down		yes	yes	yes	yes	n/a
		b		PTO returns engine to idle		n/a	n/a	n/a	n/a	no info

	2			Auxiliary engine equipped with:							
		a		Emission controls				no info	no info	no info	no info	n/a
		b	R	Electric starter				yes	yes	yes	yes	n/a
		c	R	Spark arrester qualified in accordance with USDA Forest Service Standard 5200-1				yes	yes	yes	yes	n/a
	3		R	Pump overheat protection for centrifugal pump (coolant line)				yes	no	no	yes	yes
6				**Priming**								
	1		R	Prime through 24 ft of suction hose with 10 ft lift				yes 7 s	1 min. 12 s	1 min. 15 s	8 s	13 s
	2		R	Prime and pump water through 24 ft of suction hose with 17 ft lift				18 s	3 min. 30 s	3 min.	15 s	yes
	3		R	Primer develops 17 inches/Hg, no greater than a 10 inch loss in 5 min.				20.5 inches/Hg	22 inches/Hg	19inches/Hg	22 inches/Hg	23 inches/Hg
	4			Prime with pump running				yes	no	no	yes	yes
	5		R	Water or environmentally friendly fluids discharged to ground when priming				yes	yes	yes	yes	yes
	6		R	Check valve or equivalent in priming line				yes	yes	yes	yes	yes
7				**Plumbing**								
	1			Plumbing layout as in "Water Handling Equipment Guide"				yes	no	yes	yes	yes
	2		R	All water flow into pump passes through suction strainer prior to entering pump, strainer can be quickly cleaned				no/n/a	no	no	no/n/a	yes/yes
	3			Humps in suction plumbing				no	no	no	no	yes
	4			If humps in suction plumbing priming is from top of hump and pump				n/a	n/a	n/a	n/a	no
	5			Plumbing and pump can be drained and retain a full tank of water				no	yes	no	yes	yes
	6		R	Minimum required pipe size				yes	yes	yes	yes	yes
				Pressure piping size (inch)				1-1/2	1-1/2	1-1/2	1-1/2	2
				Suction piping size (inch)				2	2	2	2	2
	7		R	Overboard suction connection				yes	yes	yes	yes	yes
	8		R	Fire hose threads				yes	yes	yes	yes	yes
					Size	Threads/inch	National Bureau of Standards symbol					yes
					3/4	11-1/2	NH	yes	yes	yes	yes	yes
					1	11-1/2	NPSH	yes	yes	yes	yes	yes
					1-1/2	9	NH	yes	yes	yes	yes	yes
					2	11-1/2	NPSH	yes	yes	yes	yes	yes
					2-1/2	7-1/2	NH	yes	yes	yes	yes	yes
					4	7-1/2	NH	yes	n/a	yes	yes	yes
8				**Valves**								
	1		R	No. 1 Tank to Pump				yes	yes	yes	yes	yes
	2		R	No. 2 Pump to Tank				yes	yes	yes	yes	yes
	3		R	No. 3 Overboard Discharge				optional	yes	yes	yes	yes
	4		R	No. 4 Hose Reel or Basket Discharge				yes	yes	yes	yes	yes
	5			No. 5 Dedicated Engine Protection Discharge				no	no	no	no	no

	6		R	No. 6 Pump to Primer (if primer installed)	yes	yes	yes	yes	yes
	7		R	No. 7 Pressure Relief Valve, if positive displacement pump installed	n/a	n/a	n/a	no	no
	8		R	No. 8 Overboard Suction to Pump	no	yes	yes	yes	no
	9			No. 9 Reserve Supply from Tank to Pump	no	no	no	no	no
	10			No. 10 In Tank Shut-off	no	no	no	no	no
	11			No. 11 Pump and Plumbing Drain Valve	no	yes	no	no	yes
	12			No. 12 Pump Coolant Clean-out	no	no	no	no	no
	13			No. 13 Gravity Tank Drain	plug	yes	yes	plug	no
	14			No. 14 Foam-Differential-Valve Shunt	no	no	no	no	no
	15			No. 15 Pump Transfer Valve	n/a	no	no	no	no
	16			No. 16 Engine Cooler	n/a	n/a	no	no	no
	17			No. 17 Pump Bypass	no	no	no	no	no
	18			No. 18 Low Volume Gravity (backpack fill)	no	yes	yes	no	no
	19		R	No. 19 Water only Valve for Eductor Use or water transfer	yes	yes	yes	no	no
	20		R	Valves 1, 2, 3, 4, 5, 6, 9, 12, 14, 16, 17, 18, & 19, 1/4-turn ball valves	yes	yes	yes	yes	yes
	21		R	Valves 8, 10, & 13, 1/4-turn valves	yes	yes	yes	yes	yes
	22			All visible 1/4-turn valves shall be in the off position when the valve handle is perpendicular to the run of the pipe and in the open position when the valve handle is parallel to the run of the pipe	yes	yes	yes	yes	yes
	23			Valves of drop out design	no	no	no	yes	yes
	24		R	Blind valves labeled open/closed	n/a	no	n/a/yes	yes	yes
	25		R	Valve functions labeled in clear text and numbers	text	no	no	yes/no	yes/yes
	26		R	Mounted metal operating instruction plate with valve positions for	yes	no	no	no	yes
				standard fire operations	yes	no	no	yes	yes
	27		R	All output of pump passes through check valve in pump discharge	yes	no	no	yes	yes
9				**Foam System**					
	1			Foam Proportioner	yes	yes	yes	yes	yes
		a	R	Discharge side	yes	yes	yes	yes	yes
		b		Automatic regulating type	yes	yes	yes	yes	yes
		c	R	Accurate within ± 30 percent	yes	yes	no	no	yes
	2			Capable of downhill foam solution at zero or low pressure while pumping uphill with foam solution under pressure	no	yes	no	no	no
	3		R	Foam proportioning system installed so foam solution does not return to the main water tank	yes	yes	yes	yes	yes
10				**Controls and Gauges**					
	1			Gauges					
		a	R	Discharge pressure gauge	yes	yes	yes	yes	yes
		b	R	Pressure gauge is compound or withstand vacuum to 30 inches/Hg	yes	no	no	yes	yes

		c		Suction pressure gauge (compound gauge to 30 inches/Hg)	no	no	no	no	no
		d	R	Water level indicator	yes	yes	yes	yes	yes
		e	R	Gauges freeze protected/by a drain near gauges	yes/no	yes/yes	yes/yes	yes/no info	n/a digital
	2		R	Pressure gauge connection at pump discharge prior to check valves	yes	yes	yes	yes	yes
	3		R	Variable twist throttle control (on gas/diesel engines)	yes	yes	yes	yes	yes
	4		R	Control panel light	yes	yes	yes	yes	yes
	5			Priming control on panel	yes	yes	yes	yes	yes
11			R	**Hose Reel/Hose Basket**	hose reel	hose reel	hose reel	hose reel	hose reel
	1		R	Electric rewind	yes	yes	yes	yes	yes
	2		R	Hose reel equipped with brake	yes	yes	yes	yes	yes
	3		R	Hose reel outlet thread—1 inch 11-3/4 NPSH	yes	yes	yes	yes	yes
12				**Fuel and Fuel Tank**					
	1			Integral units with auxiliary engine-same fuel as chassis	n/a	n/a	n/a	n/a	n/a
	2			Slip-on units—same fuel as chassis	gasoline	yes	yes	no/gasoline	n/a
	3			Fuel tank with auxiliary engine meets CFR 49					
		a	R	393.65 prohibits gravity or siphon fuel feed	no	yes	yes	yes	n/a
		b	R	393.67 requires fuel withdrawal fittings for a fuel tank, except for diesel fuel tanks, be above the normal level in the tank when the tank is full	no	yes	yes	yes	n/a
13				**PTO Integral Unit**					
	1		R	PTO and pump driveline loadings are within manufacturer's recommended maximum operating loadings	n/a	n/a	n/a	n/a	yes
14				**Chassis (for complete unit)**					
	1		R	Weight of completed vehicle, full of water, with crew members and minimum gear will be less than 90 percent of GVWR		GVWR 15,000	GVWR 31,680	GVWR 15,000	GVWR 15,000
					n/a	GVWR 15,060	GVWR 25,240	GVWR 12,820	GVWR 12,900
				Allow 250 lb/person per seating position	n/a	3	3	3	3
				Minimum miscellaneous gear weight (lb) is:	n/a	1000	1000	1000	1000
	2		R	Each axle weight when engine fully loaded less than 90 percent of GAWR					
				(Consider equipment distributed evenly throughout the truck body)	n/a	no	yes	yes	yes
	3		R	Fully enclosed personnel area	n/a	yes	yes	yes	yes
	4		R	Platforms provided for personnel to ride outside of personnel area	n/a	no	no	no	no
	5		R	Completed Vehicle Certification	n/a	yes	yes	yes	yes
15				**Storage Cabinetry**	n/a	66.9 ft^3	94.5 ft^3	71.8 ft^3	65 ft^3
	1		R	Dust and water resistant	n/a	yes	yes	yes	yes
	2			Drain in storage cabinetry	n/a	no	no	no info	yes
	3		R	Common walls with water tank	n/a	no	no	no	no

	4		R	Storage for long-handle tools and saw	n/a	yes	yes	yes	yes
	5			Storage for suction hose (three pieces of 8 ft long by piping diameter)	no	yes	yes	no (2 lengths)	yes
16				**Safety**					
	1		R	Safety Guard and Shields as necessary (CFR 29)	yes	yes	yes	yes	yes
	2		R	Back-up alarm	n/a	yes	yes	no info	yes
	3		R	Bumper height meets CFR 49 393.86 (30 inches	n/a	19.5	27	yes	18
	4		R	Emergency lights, sirens, and markings meet Forest Service policy	n/a	yes	yes	no info	yes
17				**Center of Gravity and Angles**					
	1		R	Tilt table 30 degrees before lifting front or rear tire **OR** Height of fully loaded (fire-ready) vehicle, measured at vehicle's center of gravity, must not exceed 75 percent of tread width dimension	n/a	37°	30°	35°	36°
	2		R	Approach and departure angles greater than 20 degrees	n/a	31.6°/21.1°	41°/23.3°	no info	no info
	3		R	Fire equipment decreases ramp break-over angle	n/a	no/24°	no/29.2°	no	no info
18				**Written Materials**					
	1		R	Operating instructions	yes	yes	yes	no info	yes
	2		R	Parts manual	yes	no	no	no info	yes
	3		R	Repair manual	no	no	no	no info	yes
	4		R	Fabricator's acceptance inspection and test procedures	no	yes	yes	no info	no
	5		R	Pump performance label	yes	no	no	no	no info
	6			Mounting instructions for slip-on units					
		a	R	Mounting requirements	no	no	no	no	n/a
		b	R	Minimum GVWR recommended for slip-on unit	no	15,000	24,500	15,000	n/a
		c	R	Minimum GAWR for truck carrying slip-on unit	no	6,000/11,000		5,000/10,000	n/a
		d	R	Location of center of gravity of slip-on unit	36 inches from front	no	no	no info	n/a
19				**Color Integral Unit**					
	1		R	Color code 14260, green, Federal Standard, FED-STD 595	no	yes	yes	yes	yes
		a		When not available the color may only be manufacturer's white					
	2			Vehicle marking & striping and shall be in accordance with NFPA 1906					
				and meet Forest Service Standard					
20				**Under GSA Contract**	yes	no	no	no	no
21				**Cost Slip-on Unit**	12,100 approx.	$14,873	$18,343	$24,000	
22				**Cost Fire Package and Chassis**		$47,214		$67,100	$72,000

CLASS C WILDLAND FIRE ENGINE EVALUATION RESULTS

			Required		
				Engine Class	**C**
				Equipment Designator	R-5 Model 42
1				**Engine Characteristics (Engine Capability)**	
	1			Required Pump Flow	Rated/Actual
		a		GPM (minimum) 90	98/91
		b		@pressure (psi) 300	300
	2			Required Tank Size	
		a		minimum (gal) 300	300
		b		actual (gal)	261
	3			Crew Seats 3-5	3
2				**Engine Configuration**	
	1			Integral Units (with storage cabinetry)	
		a		PTO	yes
		b		Auxiliary Engine	n/a
	2			Slip-on Units	
				Pickup or Utility Body (storage cabinetry not required)	
		a		single rear wheels	n/a
		b		dual rear wheels	n/a
	3			Stake or Flat Bed	
		a		with storage cabinetry	n/a
		b		without storage cabinetry	n/a
3				**Tank**	
	1		**R**	Size as required and fill pipe equipped with debris strainer	no
	2		**R**	Tank material corrosion-resistant to water and foam solution	no
	3		**R**	Meets NFPA standards for baffling	yes
	4		**R**	Tank venting 1/4 of the area of the larger: inlet or outlet of tank	yes
4				**Operations**	
	1		**R**	Capable of operating all fireline functions when standing on the ground	yes
	2		**R**	Capable of pump and roll attack (80 psi minimum at 2 mph maximum)	2.13 mph
	3			Pressurized source capability	
		a	**R**	Fill tank	yes
		b	**R**	Direct to pump at minimum of 125 psi	yes
5				**Pump**	
	1		**R**	Centrifugal pump engine/pump protection engages as pressure drops below 40 psi	no n/a
		a	**R**	Auxiliary engine shuts down	n/a
		b	**R**	PTO returns engine to idle	no
	2			Auxiliary engine equipped with:	
		a		Emission controls	n/a
		b	**R**	Electric starter	n/a
		c	**R**	Spark arrester qualified in accordance with USDA Forest Service Standard 5200-1	n/a
	3		**R**	Pump overheat protection for centrifugal pump (coolant line)	yes

6				**Priming**				
	1		**R**	Prime through 24 ft of suction hose with 10 ft lift				11 s
	2		**R**	Prime and pump water through 24 ft of suction hose with 17 ft lift				12 s
	3		**R**	Primer develops 17 inches/Hg, no greater than a 10 inch loss in 5 min.				19.5 inches/Hg
	4			Prime with pump running				yes
	5		**R**	Water or environmentally friendly fluids discharged to ground when priming				yes
	6		**R**	Check valve or equivalent in priming line				yes new units
7				**Plumbing**				
	1			Plumbing layout as in "Water Handling Equipment Guide"				yes
	2		**R**	All water flow into pump passes through suction strainer prior to entering pump, strainer can be quickly cleaned				yes
	3			Humps in suction plumbing				yes
	4		**R**	If humps in suction plumbing priming is from top of hump and pump				yes
	5			Plumbing and pump can be drained and retain a full tank of water				yes
	6		**R**	Minimum required pipe size				yes
				Pressure piping size (inch)				1-1/2
				Suction piping size (inch)				2
	7		**R**	Overboard suction connection				yes
	8		**R**	Fire hose threads				yes
					Size	Threads/inch	National Bureau of Standards symbol	
					3/4	11-1/2	NH	yes
					1	11-1/2	NPSH	yes
					1-1/2	9	NH	yes
					2	11-1/2	NPSH	yes
					2-1/2	7-1/2	NH	yes
					4	7-1/2	NH	yes
8				**Valves**				
	1		**R**	No. 1 Tank to Pump				yes
	2		**R**	No. 2 Pump to Tank				yes
	3		**R**	No. 3 Overboard Discharge				yes
	4		**R**	No. 4 Hose Reel or Basket Discharge				yes
	5			No. 5 Dedicated Engine Protection Discharge				no
	6		**R**	No. 6 Pump to Primer (if primer installed)				yes
	7		**R**	No. 7 Pressure Relief Valve, if positive displacement pump installed				no
	8		**R**	No. 8 Overboard Suction to Pump				yes
	9			No. 9 Reserve Supply from Tank to Pump				no
	10			No. 10 In Tank Shutoff				no
	11			No. 11 Pump and Plumbing Drain Valve				yes
	12			No. 12 Pump Coolant Cleanout				yes
	13			No. 13 Gravity Tank Drain				no
	14			No. 14 Foam Differential Valve Shunt				no
	15			No. 15 Pump Transfer Valve				no
	16			No. 16 Engine Cooler				no
	17			No. 17 Pump Bypass				no
	18			No. 18 Low Volume Gravity (backpack fill)				no

	19		**R**	No. 19 Water Only Valve for Eductor Use or Water Transfer	yes, 5
	20		**R**	Valves 1, 2, 3, 4, 5, 6, 9, 12, 14, 16, 17, 18, & 19, 1/4-turn ball valves	yes
	21		**R**	Valves 8, 10, & 13, 1/4-turn valves	yes
	22			All visible 1/4-turn valves shall be in the off position when the valve handle is perpendicular to the run of the pipe and in the open position when the valve handle is parallel to the run of the pipe	yes
	23			Valves of drop out design	yes
	24		**R**	Blind valves labeled open/closed	no
	25		**R**	Valve functions labeled in clear text and numbers	no/yes
	26		**R**	Mounted metal operating instruction plate with valve positions for standard fire operations	yes
	27		**R**	All output of pump passes through check valve in pump discharge	yes
9				**Foam System**	
	1			Foam Proportioner	yes
		a	**R**	Discharge side	yes
		b	**R**	Automatic regulating type	yes
		c	**R**	Accurate within ± 30 percent	no
	2			Capable of downhill foam solution at zero or low pressure while pumping uphill with foam solution under pressure	no
	3		**R**	Foam proportioning system installed so foam solution does not return to the main water tank	yes
10				**Controls and Gauges**	
	1			Gauges	
		a	**R**	Discharge pressure gauge	yes
		b	**R**	Pressure gauge is compound or withstand vacuum to 30 inches/Hg	yes
		c	R	Suction pressure gauge (compound gauge to 30 inches/Hg)	no
		d	R	Water level indicator	yes
		e	R	Gauges freeze protected/by a drain near gauges	yes/no
	2		R	Pressure gauge connection at pump discharge prior to check valves	no
	3		R	Variable twist throttle control (on gas/diesel engines)	yes
	4		R	Control panel light	yes
	5		R	Priming control on panel	yes
11			**R**	**Hose Reel/Hose Basket**	hose basket
	1		**R**	Electric rewind	yes
	2		**R**	Hose reel equipped with brake	yes
	3		**R**	Hose reel outlet thread—1 inch 11-3/4 NPSH	yes
12				**Fuel and Fuel Tank**	
	1			Integral units with auxiliary engine-same fuel as chassis	n/a
	2			Slip-on units—same fuel as chassis	n/a
	3			Fuel tank with auxiliary engine meets CFR 49	
		a	**R**	393.65 prohibits gravity or siphon fuel feed	n/a
		b	**R**	393.67 requires fuel withdrawal fittings for a fuel tank, except for diesel fuel tanks, be above the normal level in the tank when the tank is full	n/a

13				**PTO Integral Unit**	
	1		**R**	PTO and pump driveline loadings are within manufacturer's	
				recommended maximum operating loadings	yes
14				**Chassis (for complete unit)**	
	1		**R**	Weight of completed vehicle, full of water, with crew members and	GVWR 25,500
				minimum gear will be less than 90 percent of GVWR	GVWR 16,920
				Allow 250 lb/person per seating position	3
				Minimum miscellaneous gear weight (lb) is:	1500
	2		**R**	Each axle weight when engine fully loaded less than 90 percent of GAWR	
				(Consider equipment distributed evenly throughout the	
				truck body)	yes
	3		**R**	Fully enclosed personnel area	yes
	4		**R**	Platforms provided for personnel to ride outside of personnel area	no
	5		**R**	Completed Vehicle Certification	yes
15			**R**	**Storage Cabinetry**	101 ft^3
	1		**R**	Dust and water resistant	yes
	2			Drain in storage cabinetry	no
	3		**R**	Common walls with water tank	no
	4		**R**	Storage for long-handle tools and saw	yes
	5		**R**	Storage for suction hose (three pieces of 8 ft long by piping diameter)	yes
16				**Safety**	
	1		**R**	Safety Guard and Shields as necessary (CFR 29)	yes
	2		**R**	Back-up alarm	yes
	3		**R**	Bumper height meets CFR 49 393.86 (30 inches)	19 3/4
	4		**R**	Emergency lights, sirens, and markings meet Forest Service policy	yes
17				**Center of Gravity and Angles**	
	1		**R**	Tilt table 30 degrees before lifting front or rear tire **OR** Height of fully loaded (fire-ready) vehicle, measured at vehicle's center of gravity, must not exceed 75 percent of tread width dimension	37°
	2		**R**	Approach and departure angles greater than 20 degrees	34°/20°
	3		**R**	Fire equipment decreases ramp break-over angle	no/25°
18				**Written Materials**	
	1		**R**	Operating instructions	yes
	2		**R**	Parts manual	yes
	3		**R**	Repair manual	no
	4		**R**	Fabricator's acceptance inspection and test procedures	no
	5		**R**	Pump performance label	no
	6			Mounting instructions for slip-on units	
		a	**R**	Mounting requirements	n/a
		b	**R**	Minimum GVWR recommended for slip-on unit	n/a
		c	**R**	Minimum GAWR for truck carrying slip-on unit	n/a
		d	**R**	Location of center of gravity of slip-on unit	n/a
19				**Color Integral Unit**	
	1		**R**	Color code 14260, green, Federal Standard, FED-STD 595	yes
		a		When not available the color may only be manufacturer's white	

	2			Vehicle marking & striping and shall be in accordance with NFPA 1906	
				and meet Forest Service Standard	
20				**Under GSA Contract**	no
21				**Cost Slip-on Unit**	$68,000
22				**Cost Fire Package and Chassis**	

			Required								
				Engine Class	D	D	D	D	D	D	D
				Equipment Designator	R-3 Model 46	R-3 Model 71	R-5 Model 62	R-5 Model 62 4x4	R-5 Prototype	R-6 Model 75	R-6 Model 80
1				**Engine Characteristics (Engine Capability)**							
	1			Required Pump Flow	Rated/Actual	Rated/Actual	Rated/Actual	Rated/Actual	Rated/Actual	Rated/Actual	Rated/Actual
		a		GPM (minimum) 200	200/155	200/173	250/300	94/93 &350/392	200/225	200/137	200/185
		b		@pressure (psi) 300	300	300	300	400/300	400	300	300
	2			Required Tank Size							
		a		minimum (gal) 500	500	500	500	500	500	500	500
		b		actual (gal)	545	621	545	545	480	530	984
	3			Crew Seats 3–5	3	5	5	5	5	3	3
2				**Engine Configuration**							
	1			Integral Units (with storage cabinetry)							
		a	R	PTO	yes	yes	yes	yes	yes	yes	yes
		b		Auxiliary Engine	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2			Slip-on Units							
				Pickup or Utility Body (storage cabinetry not required)							
		a		single rear wheels	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		b		dual rear wheels	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	3			Stake or Flat Bed							
		a		with storage cabinetry							
		b		without storage cabinetry							
3				**Tank**							
	1		R	Size as required and fill pipe equipped with debris strainer	yes	yes/no	yes	yes/yes	yes/yes	yes	yes
	2		R	Tank material corrosion-resistant to water and foam solution	yes	no	yes	yes	yes	yes	yes
	3		R	Meets NFPA standards for baffling	yes	yes	yes	yes	yes	yes	yes
	4		R	Tank venting 1/4 of the area of the larger: inlet or outlet of tank	yes	yes	yes	yes	yes	yes	yes
4				**Operations**							
	1		R	Capable of operating all fireline functions when standing on the ground	yes	yes	yes	yes	yes	yes	yes
	2		R	Capable of pump and roll attack (80 psi minimum at 2 mph maximum)	no 2.29 mph	yes	1.82 mph	1.3 mph	1–60 mph	yes 1.24 or lower	yes 1.00

	3			Pressurized source capability							
		a	R	Fill tank	yes	yes	yes	yes		yes	yes
		b	R	Direct to pump at minimum of 125 psi	yes	yes	yes	yes	yes	yes	yes
5				**Pump**							
	1		R	Centrifugal pump engine/pump protection engages as pressure drops below 40 psi	no	no	no	no	yes	no	no
		a		Auxiliary engine shuts down	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		b	R	PTO returns engine to idle	no	no	no	no	yes	no	no
	2			Auxiliary engine equipped with:							
		a		Emission controls	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		b		Electric starter	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		c		Spark arrester qualified in accordance with USDA Forest Service Standard 5200-1	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	3		R	Pump overheat protection for centrifugal pump (coolant line)	yes	yes	yes	yes	yes	yes	yes
6				**Priming**							
	1		R	Prime through 24 ft of suction hose with 10 ft lift	21 s	15 s	8 s	6 s	7 s	15 s	13 s
	2		R	Prime and pump water through 24 ft of suction hose with 17 ft lift	23 s	yes	14 s	16 s	12 s	yes	15 s
	3		R	Primer develops 17 inches/Hg, no greater than a 10 inch loss in 5 min.	24 inches /Hg	24.5 inches/ Hg	22 inches/ Hg	yes	24 inches/ Hg	21.5 inches/ Hg	22.5 inches/ Hg
	4			Prime with pump running	yes	yes	yes	yes	yes	yes	yes
	5		R	Water or environmentally friendly fluids discharged to ground when priming	yes	yes	yes	yes	yes	yes	yes
	6		R	Check valve or equivalent in priming line	yes	yes	yes	yes	yes	yes	yes
7				**Plumbing**							
	1			Plumbing layout as in "Water Handling Equipment Guide"	yes	yes	yes	yes	yes	yes	yes
	2		R	All water flow into pump passes through suction strainer prior to entering pump, strainer can be quickly cleaned	yes	yes	yes	yes	yes	yes/yes	yes/yes
	3			Humps in suction plumbing	yes	yes	yes	yes	yes	yes	yes
	4		R	If humps in suction plumbing priming is from top of hump and pump	yes	yes	yes	yes	yes	yes	yes
	5			Plumbing and pump can be drained and retain a full tank of water	no	yes	yes	yes	yes	yes	yes
	6		R	Minimum required pipe size	yes	yes	yes	yes	yes	yes	yes
				Pressure piping size (inch)	2	2	3	3	3	2	2
				Suction piping size (inch)	3	3	4	4	4	3	3
	7		R	Overboard suction connection	yes	yes	yes	yes	yes	yes	yes

	8		R	Fire hose threads				yes	yes	yes	yes	yes	yes	yes
					Size	Threads/ inch	National Bureau of Standards symbol							
					3/4	11-1/2	NH	yes	yes	yes	yes	yes	yes	yes
					1	11-1/2	NPSH	yes	yes	yes	yes	yes	yes	yes
					1-1/2	9	NH	yes	yes	yes	yes	yes	yes	yes
					2	11-1/2	NPSH	yes	yes	yes	yes	yes	yes	yes
					2-1/2	7-1/2	NH	yes	yes	yes	yes	yes	yes	yes
					4	7-1/2	NH	yes	yes	yes	yes	yes	yes	yes
8				**Valves**										
	1		R	No. 1 Tank to Pump				yes	yes	yes	yes	yes	yes	yes
	2		R	No. 2 Pump to Tank				yes	yes	yes	yes	yes	yes	yes
	3		R	No. 3 Overboard Discharge				yes	yes	yes	yes	yes	yes	yes
	4		R	No. 4 Hose Reel or Basket Discharge				yes	yes	yes	yes	yes	yes	yes
	5			No. 5 Dedicated Engine Protection Discharge				no	no	no	no	no	no	no
	6		R	No. 6 Pump to Primer (if primer installed)				yes	yes	yes	yes	yes	yes	yes
	7		R	No. 7 Pressure Relief Valve, if positive displacement pump installed				no	no	yes	yes	no	no	no
	8		R	No. 8 Overboard Suction to Pump				yes	yes	yes	yes	yes	no	no
	9			No. 9 Reserve Supply from Tank to Pump				no	no	no	no	no	no	no
	10			No. 10 In Tank Shut-off				no	no	no	no	no	no	no
	11			No. 11 Pump and Plumbing Drain Valve				yes	no	yes	yes		yes	yes
	12			No. 12 Pump Coolant Clean-out				no	yes	no	no	no	no	no
	13			No. 13 Gravity Tank Drain				no	no	yes	yes	yes	yes	yes
	14			No. 14 Foam-Differential-Valve Shunt				no	yes	no	no	no	no	no
	15			No. 15 Pump Transfer Valve				n/a	n/a	yes	yes	yes	n/a	n/a
	16			No. 16 Engine Cooler				no	no	no	no	no	no	no
	17			No. 17 Pump Bypass				no	no	no	yes	yes	no	no
	18			No. 18 Low Volume Gravity (backpack fill)				no	no	yes	yes	yes	no	no
	19		R	No. 19 Water only Valve for Eductor Use or water transfer				no	no	no	no	yes	no	no
	20		R	Valves 1, 2, 3, 4, 5, 6, 9, 12, 14, 16, 17, 18, & 19, 1/4-turn ball valves				yes	yes	no	no	yes	yes	yes
	21		R	Valves 8, 10, & 13, 1/4-turn valves				yes	yes	yes	yes	yes	yes	yes
	22			All visible 1/4-turn valves shall be in the off position when the valve handle is perpendicular to the run of the pipe and in the open position when the valve handle is parallel to the run of the pipe				yes	yes	yes	yes	yes	yes	yes
	23			Valves of drop out design				yes	yes	yes	yes	yes	yes	yes
	24		R	Blind valves labeled open/closed				yes	yes	yes	yes	yes	yes	yes
	25		R	Valve functions labeled in clear text and numbers				no/no	no/yes	yes/yes	yes/yes	yes/yes	yes/no info	no/yes

	26		R	Mounted metal operating instruction plate with valve positions for standard fire operations	no	yes	yes	yes	yes	yes	yes
	27		R	All output of pump passes through check valve in pump discharge	yes	yes	yes	yes	yes	yes	yes
9				**Foam System**							
	1			Foam Proportioner	yes	yes	yes	yes	yes	yes	yes
		a	R	Discharge side	yes	yes	yes	yes	yes	yes	yes
		b	R	Automatic regulating type	yes	yes	yes	yes	yes	yes	yes
		c	R	Accurate within ± 30 percent	no	no	yes	yes	yes	yes	no
	2			Capable of downhill foam solution at zero or low pressure while pumping uphill with foam solution under pressure	no	no	no	no	no	no	no
	3		R	Foam proportioning system installed so foam solution does not return to the main water tank	no	yes	yes	yes	yes	yes	yes
10				**Controls and Gauges**							
	1			Gauges							
		a	R	Discharge pressure gauge	yes	yes	yes	yes	yes	yes	yes
		b	R	Pressure gauge is compound or withstand vacuum to 30 inches/Hg	yes	yes	yes	yes	yes	yes	yes
		c	R	Suction pressure gauge (compound gauge to 30 inches/Hg)	no	yes	yes	yes	yes	no	no
		d	R	Water level indicator	yes	yes	yes	yes	yes	yes	yes
		e	R	Gauges freeze protected/by a drain near gauges	yes/no	yes/no	yes/no	yes/no	yes/no	yes/yes	yes/yes
	2		R	Pressure gauge connection at pump discharge prior to check valves	yes	yes	yes	yes	no	yes	yes
	3		R	Variable twist throttle control (on gas/diesel engines)	yes	yes	yes	yes	yes	yes	yes
	4		R	Control panel light	yes	yes	yes	yes	yes	yes	yes
	5		R	Priming control on panel	yes	yes	yes	yes	yes	yes	yes
11			R	**Hose Reel/Hose Basket**	Hose Reel	Hose Reel	Hose Reel	Hose Reel	Hose Reel	Hose Reel	Hose Reel
	1			Electric rewind	yes	yes	yes	yes	yes	yes	yes
	2		R	Hose reel equipped with brake	yes	yes	yes	yes	yes	yes	yes
	3		R	Hose reel outlet thread—1 inch 11-3/4 NPSH	no	yes	yes	yes	yes	yes	yes
12				**Fuel and Fuel Tank**							
	1			Integral units with auxiliary engine-same fuel as chassis	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2			Slip-on units—same fuel as chassis	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	3			Fuel tank with auxiliary engine meets CFR 49							
		a	R	393.65 prohibits gravity or siphon fuel feed	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		b	R	393.67 requires fuel withdrawal fittings for a fuel tank, except for diesel fuel tanks, be above the normal level in the tank when the tank is full	n/a	n/a	n/a	n/a	n/a	n/a	n/a
13				**PTO Integral Unit**							
	1		R	PTO and pump driveline loadings are within manufacturer's recommended maximum operating loadings	no	yes	yes	yes	yes	yes	yes

14				**Chassis (for complete unit)**							
	1		R	Weight of completed vehicle, full of water, with crew members and	GVWR 31,200	GVWR 33,000	GVWR 33,000	GVWR 33,000	GVWR 33,000	GVWR 31,000	GVWR 33,000
				minimum gear will be less than 90 percent of GVWR	GVWR 23,440	GVWR 25,060	GVWR 26,840	GVWR 27,620	GVWR 27,760	GVWR 24,480	GVWR 27,700
				Allow 250 lb/person per seating position	3	3	5	5	5	3	3
				Minimum miscellaneous gear weight (lb) is:	2000	2000	2000	2000	2000	2000	2000
	2		R	Each axle weight when engine fully loaded less than 90 percent of GAWR (Consider equipment distributed evenly throughout the truck body)	yes	yes	yes	yes	yes	yes	no (F71%, R90.9%)
	3		R	Fully enclosed personnel area	yes	yes	yes	yes	yes	yes	yes
	4		R	Platforms provided for personnel to ride outside of personnel area	no	no	no	no	no	no	no
	5		R	Completed Vehicle Certification	no	yes	yes	yes	yes	yes	yes
15			R	**Storage Cabinetry**	75.2 ft^3	84.8 ft^3	68.7 ft^3	68.7 ft^3		80 ft^3	110 ft^3
	1		R	Dust and water resistant	yes	yes	yes	yes	yes	yes	yes
	2			Drain in storage cabinetry	no	yes	no	no	no	yes	yes
	3		R	Common walls with water tank	no	no	no	no	no	no	no
	4		R	Storage for long-handle tools and saw	yes	yes	yes	yes	yes	yes	yes
	5		R	Storage for suction hose (three pieces of 8 ft long by piping diameter)	yes	yes	yes	yes	yes	yes	yes
16				**Safety**							
	1		R	Safety Guard and Shields as necessary (CFR 29)	yes	yes	yes	yes	yes	yes	yes
	2		R	Back-up alarm	yes	yes	yes	yes	yes	yes	yes
	3		R	Bumper height meets CFR 49 393.86 (30 inches)	yes (24 inches)	yes	yes (19 inches)	yes (26 inches)	yes (28 inches)	yes (25 inches)	yes (23 inches)
	4		R	Emergency lights, sirens, and markings meet Forest Service Standards	yes	yes	yes	yes	yes	yes	yes
17				**Center of Gravity and Angles**							
	1		R	Tilt table 30 degrees before lifting front or rear tire **OR** Height of fully loaded (fire-ready) vehicle, measured at vehicle's center of gravity, must not exceed 75 percent of tread width dimension	32.2°	32.8°	34.5°	30.2°	31.8°	34.5°	32°
	2		R	Approach and departure angles greater than 20 degrees	42.2°/22.6°	no info	no info	35.7°/21.8°	30.5°/25.4°	no (32.7° & 19.8°)	no info
	3		R	Fire equipment decreases ramp break over angle	no/24.3	no info	no	no (25.5°)		yes 26.2	no info
18				**Written Materials**							
	1		R	Operating instructions	no	yes	yes	yes	yes	yes	yes
	2		R	Parts manual	yes	yes	yes	yes	yes	yes	yes
	3		R	Repair manual	no	yes	yes	yes	yes	no	no
	4		R	Fabricator's acceptance inspection and test procedures	no	no	yes	yes	yes	no	no info
	5		R	Pump performance label	no	no	yes	yes	yes	no	no

	6			Mounting instructions for slip-on units							
		a	**R**	Mounting requirements	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		b	**R**	Minimum GVWR recommended for slip-on unit	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		c	**R**	Minimum GAWR for truck carrying slip-on unit	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		d	**R**	Location of center of gravity of slip-on unit	n/a	n/a	n/a	n/a	n/a	n/a	n/a
19				**Color Integral Unit**							
	1		**R**	Color code 14260, green, Federal Standard, FED-STD 595	yes	yes	yes	yes	yes	yes	yes
		a		When not available the color may only be manufacturer's white							
	2			Vehicle marking & striping and shall be in accordance with NFPA							
				1906 and meets Forest Service Standard							
20				**Under GSA Contract**	no	no	yes	yes	yes	no	no
21				**Cost Slip-on Unit**							$73,6000
22				**Cost Fire Package and Chassis**	$84,000	$99,000	$140,000	$160,000		140,000 (4x4)	$123,500

DESCRIPTIONS OF CLASS LP WILDLAND FIRE ENGINES TESTED

Summary of the Class LP fire engine tested at SDTDC.

Agency:
Equipment Designator: **MB58-PO**
Year: 1998
NWFEC Class: LP
Tank Capacity: 32 gallon
Pump Rating: 9 gpm @ 150 psi
Pump Drive: 5.5 ohv hp gas engine
GVWR: 595 pounds
Contract:
Price: $5,885 complete

General Information:
The MB58-PO uses a 5.5 ohv hp gas engine to power a bronze rated 13-gpm 150-psi positive displacement pump. The pump motor pulls out of the main housing to become a portable pump. The MB58-PO includes a foam system and 1 inch discharge. The MB58-GEN, a self-contained slip-on with a generator, was not tested for this publication.

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DESCRIPTIONS OF CLASS A WILDLAND FIRE ENGINES TESTED

Summary of the Class A wildland fire engine tested at SDTDC.

Agency: USDA FS
Equipment Designator: **Robwen Model 180 Slip-On**
Year: 1998
NWFEC Class: A

Tank Capacity:	96 gallon
Pump Rating:	52 gpm @ 200 psi
Pump Drive:	Auxiliary engine
GVWR:	N/A
Contract:	GSA
Price:	$10,000 fire package only

General Information:
The Robwen Model FS180 is a slip-on unit with a Robwen Model 1890 centrifugal pump and a Model 500 positive pressure foam proportioner. Robwen designed its Model 180 to mate with the Briggs and Stratton 18-hp Vanguard engine. The pump and foam proportioner are mounted on an aluminum diamond plate skid base. The slip-on is plumbed with brass, stainless, and hard-anodized aluminum fittings. Added features include a Hannay hose reel, hour meter, and spark arrester.

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DESCRIPTIONS OF CLASS B WILDLAND FIRE ENGINES TESTED

Class B wildland fire engines tested at SDTDC.

Agency: USDA FS R-2
Equipment Designator: **Model 52**
Year: 1997
NWFEC Class: B
Tank Capacity: 290 gallon
Pump Rating: 80 gpm @ 200 psi
Pump Drive: Auxiliary engine
GVWR: 15,000 pounds
Contract: R-1
Price: $47,214 complete
$14,214 fire package only

General Information:
The Model 52 is designed to fit on an 8- or 9-foot flatbed truck with a 15,000-pound GVWR. It has a cab to axle distance of 60 inches and a 5- or 6-speed manual transmission. The Model 52 consists of a Wajax Model BB-4 pump, storage compartments, exposed plumbing, an around-the-pump foam system, and a 290-gallon fiberglass water tank.

Agency: USDA FS R-4
Equipment Designator: **Model 52 4X4**
Year:
NWFEC Class: B
Tank Capacity: 620 gallons
Pump Rating: 80 gpm @ 200 psi
Pump Drive: Auxiliary engine
GVWR: 33,000 pounds
Contract: R-1
Price: $17,976 fire package only

General Information:
The Model 52 is mounted on a 24,500 to 33,000 pound GVWR 4X2 or 4X4 truck with a cab to axle distance of 84 inches and a 5- or 6-speed manual transmission. The Model 52 consists of a Wajax Model BB-4, four stage centrifugal pump and hand primer, a hose reel, storage compartments, plumbing, and a 620-gallon (useable water) fiberglass water tank.

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DESCRIPTIONS OF CLASS B WILDLAND FIRE ENGINES TESTED

Agency: USDA FS R-5
Equipment Designator: **Model 33U**
Year:
NWFEC Class: B

Tank Capacity:	262 gallons
Pump Rating:	70 gpm @ 200 psi
Pump Drive:	Auxiliary engine
GVWR:	15,000 pounds
Contract:	R-6
Price:	$59,700 complete $24,300 fire package only $12,800 utility box

General Information:
The Model 33U is built on a Ford or General Motors 15,000 pound GVWR chassis. It has a wheelbase of 136 inches, a cab to axle distance of 60 inches, a turbo diesel engine, and a 5- or 6-speed manual transmission. The fire package includes a Wildfire Pacific BB-4 auxiliary pump, stainless steel welded plumbing, one-quarter-turn drop out style valves, Hale oilless primer, Robwen Model 500 foam proportioner, and a 262-gallon (useable water) polypropylene water tank with a built-in 15-gallon foam concentrate reservoir.

Agency: USDA FS R-6
Equipment Designator: **Model 45**
Year:
NWFEC Class: B

Tank Capacity:	312 gallons
Pump Rating:	70 gpm @ 200 psi
Pump Drive:	PTO
GVWR:	15,000 pounds
Contract:	R-6
Price:	$64,700 complete $42,100 fire package and utility box

General Information:
The Model 45 is built on a Ford or General Motors 15,000 pound GVWR chassis. It has a wheelbase of 136 inches, a cab to axle distance of 60 inches, a turbo diesel engine, and a 5- or 6-speed manual transmission. The fire package includes a Gorman Rupp 02F1 PTO pump, stainless steel welded plumbing, one-quarter-turn drop out style valves, Hale oilless primer, Robwen Model 500 foam proportioner, and a 312-gallon (useable water) polypropylene water tank with a built-in 25-gallon foam concentrate reservoir.

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Agency: USDA FS
Equipment Designator: **Wildfire Pacific Slip-On**
Year: 1998
NWFEC Class: B

Tank Capacity:	235 gallons
Pump Rating:	80 gpm @ 200 psi
Pump Drive:	Auxiliary engine
GVWR:	N/A
Contract:	GSA
Price:	$13,000

General Information:
The Wildfire Pacific Slip-on unit is on the GSA Federal Supply Schedule, contract #GS07f-5128A. The unit has a Briggs and Stratton 18-hp gasoline engine driving a four-stage centrifugal pump. A Flow Mix 500 proportioner, along with plumbing and a 235-gallon fiberglass tank complete the unit. Other tank sizes are available.

DESCRIPTIONS OF CLASS C WILDLAND FIRE ENGINES TESTED

Summary of the Class C wildland fire engine tested at SDTDC.

Agency: USDA FS R-5
Equipment Designator: **Model 42**
Year: 1990
NWFEC Class: C
Tank Capacity: 261 gallons
Pump Rating: 94 gpm @ 300 psi
Pump Drive: PTO
GVWR: 22,500 pounds
Contract: R-5
Price: $68,000 complete

General Information:
The Model 42 is built on a Ford F-Series 24,000 pound GVWR chassis. It has a wheelbase of 129 inches, a cab to axle distance of 60 inches, a 170-hp Ford diesel engine, and a 5-speed manual transmission. The Model 42 fire package includes a transmission PTO, a Waterous CPK1 pump, a KK foam proportioner, a hose reel and tank top hose tray or hose basket, emergency lighting, control panel, 261-gallon (useable water) galvanized water tank, and storage compartments.

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Summary of Class D wildland fire engines tested at SDTDC.

Agency: USDA FS R-3
Equipment Designator: **Model 46**
Year: 1992
NWFEC Class: D
Tank Capacity: 545 gallons
Pump Rating: 200 gpm @ 300 psi
Pump Drive: PTO
GVWR: 31,200 pounds
Contract: R-5
Price: $84,000 complete

General Information:
The Model 46 is built on a 30,000 to 33,000 pound GVWR chassis with an 84-inch cab to axle distance and has a 5- or 6-speed manual transmission. The Model 46 fire package consists of a Hale CBP centrifugal pump driven by a transmission PTO, Hale fluidless primer, flow mix proportioner, a hose reel, control panel, 545-gallon (useable water) polypropylene water tank, and storage compartments for suction hose and accessories.

Agency: USDA FS R-3
Equipment Designator: **Model 71**
Year: 1994
NWFEC Class: D
Tank Capacity: 621 gallons
Pump Rating: 200 gpm @ 300 psi
Pump Drive: PTO
GVWR: 33,000 pounds
Contract: R-5
Price: $99,000

General Information:
The Model 70/71 is built on a Navistar International 4900 chassis (conventional cab for Model 70, crew cab for the Model 71). The engine is an International DT-466E, inline 6-cylinder diesel with 210 hp. The transmission is a 6-speed manual Fuller FS-8206A. The Model 70/71 fire package consists of a transmission PTO, Hale Model CBP-4 pump, Hale oilless primer, Flow Mix proportioner, 2 Hannay live reels, emergency lighting, control panel, 621-gallon (useable water) polypropylene tank, and storage compartments.

DESCRIPTIONS OF CLASS D WILDLAND FIRE ENGINES TESTED

Agency: USDA FS R-5
Equipment Designator: **Model 62 4X2**
Year: 1997
NWFEC Class: D

Tank Capacity:	545 gallons
Pump Rating:	250 gpm @ 300 psi
Pump Drive:	PTO
GVWR:	33,000 pounds
Contract:	GSA
Price:	$140,000 complete

General Information:
The Model 62 body build-up is on a Navistar International 4900 Crew Cab chassis with a 9-inch extension (approximately). The wheelbase is 170 inches with a cab to axle distance of 55 inches. The engine is an International DT-466E, electronic diesel with 250 hp at 2300 rpm. The transmission is a 6-speed manual Fuller FS-8206A, with a 2-speed rear axle. The Model 62 4X2 fire package consists of a transmission PTO, a Darley JMP-500 two-stage pump, FoamPro 2001 proportioner, 2 Hannay live reels, emergency lighting, control panel, and 545-gallon (useable water) polypropylene tank, and storage compartments for hose and accessories. This transmission is no longer available. The unit now uses an Allison 6-speed MD 3560.

Agency: USDA FS R-5
Equipment Designator: **Model 62 4X4**
Year: 1997
NWFEC Class: D

Tank Capacity:	545 gallons
Volume Pump:	392 gpm @ 300 psi
Pressure Pump:	93 gpm @ 400 psi
Pump Drive:	PTO
GVWR:	33,000 pounds
Contract:	GSA
Price:	$140,000

General Information:
The Model 62 body build-up is on a Navistar International 4900 Crew Cab chassis with a 9-inch extension (approximately). The wheelbase is 170 inches with a cab to axle distance of 55 inches. The engine is an International DT-466E, electronic diesel with 250 hp at 2300 rpm. The transmission is a 6-speed manual, Fuller FS-8206A. The Model 62 4x4 fire package consists of a transmission PTO, a Darley HM-500 pump (driven off the transfer case for stationary pumping), a Waterous CK1 (for pump and roll capability), a FoamPro 2001 proportioner, 2 Hannay live reels, emergency lighting, control panel, and 545-gallon (useable water) polypropylene tank, and storage compartments for hose and accessories.

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Agency: USDA FS R-5
Equipment Designator: **Model 62 Prototype**
Year: 1999
NWFEC Class: D

Tank Capacity:	480 gallon
Volume Pump:	315 gpm @ 150 psi
Pressure Pump:	400 gpm @ 150 psi
Pump Drive:	PTO
GVWR:	33,000 pounds
Contract:	GSA
Price:	$170,000

General Information:
The Model 62 body build-up is on a Navistar International 4900 Crew Cab chassis with a 9-inch extension (approximately). The wheelbase is 170 inches with a cab to axle distance of 55 inches. The engine is an International DT-530E, electronic diesel with 250 hp at 2300 rpm. The transmission is an Allison Model MD3560. The Model 62 Prototype fire package consists of a transmission PTO, a Darley JMP-500 pump, a FoamPro 2001 proportioner, an optional CAFS System 120 CFM at 125 psi, 2 Hannay live reels, emergency lighting, control panel, a 480-gallon (useable water) polypropylene tank, and storage compartments for hose and accessories.

Agency: USDA FS R-6
Equipment Designator: **Model 75**
Year: 1994
NWFEC Class: D

Tank Capacity:	530 gallons
Pump Rating:	200 gpm @ 300 psi
Pump Drive:	PTO
GVWR:	31,000 pounds
Contract:	R-6
Price:	$119,800 complete $69,900 fire package and utility box

General Information:
The Model 75 is built on a Ford F-Series, International "S" Series, or Freightliner FL70 28,000 pound GVWR chassis. The wheelbase is 157 inches with a cab-to-axle distance of 84 inches. It has a 235- to 250-hp turbo diesel engine, an Allison 5-or 6-speed automatic transmission, and either an Allison transmission retarder or a Telma electric driveline retarder. The fire package includes a Darley HM250 PTO pump, stainless steel welded plumbing, one quarter-turn drop out style valves, a Hale fluidless primer, a FoamPro 2001 proportioner, and a 530-gallon (useable water) polypropylene tank with a 50-gallon foam concentrate reservoir.

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DESCRIPTIONS OF CLASS D WILDLAND FIRE ENGINES TESTED

Agency: USDA FS R-6
Equipment Designator: **Model 80**
Year: 1995
NWFEC Class: D

Tank Capacity:	984 gallons
Pump Rating:	200 gpm @ 300 psi
Pump Drive:	PTO
GVWR:	33,000 pounds
Contract:	R-6
Price:	$123,500 complete $73,600 fire package and utility box

General Information:
The Model 80 is built on a Ford F-Series, International "S" Series, or Freightliner FL70 32,000 pound GVWR chassis. The wheelbase is 180 inches with a cab to axle distance of 108 inches. It has a 235- to 250-hp turbo diesel engine, an Allison 5-or 6-speed automatic transmission, and either an Allison transmission retarder or a Telma electric driveline retarder. The fire package includes a Darley HM250 PTO pump, stainless steel welded plumbing, one-quarter-turn drop out style valves, a Hale fluidless primer, a FoamPro 2001 proportioner, and a 984-gallon (useable water) polypropylene tank with a 50-gallon foam concentrate reservoir.

TANKS

The proper tank design can contribute greatly to the safety and longevity of the fire vehicle. Since the vehicle's center of gravity must be low, and because a large tank full of water is very heavy, the placement and size of the tank is important. Low profile, rectangular shaped tanks are preferred since they provide better stability on side slopes and while cornering. Place tanks so that the center of gravity is on, or just ahead of, the rear axle. With slip-on units, if the payload is too far forward, the result is often overloading of the front axle.

Baffles are essential inside the tank to prevent massive water shifts on slopes or curves. Without baffles, large changes in water momentum can occur that could cause a roll over of the vehicle, or tank failure. Baffles should be installed to allow waterflow at the bottom and airflow at the top.

Tanks are usually constructed of mild steel, stainless steel, fiberglass, or polyurethane. The choice of material is based on cost, ease of manufacture, tank weight, and corrosion resistance. Mild steel tanks should be protected from corrosion. Stainless steel tanks are more corrosion resistant, but can be expensive. Fiberglass and polyurethane tanks are generally more costly than steel tanks, but are corrosion free.

Due to the cleaning action of foam, which leads to corrosion, using steel tanks in a vehicle equipped with a foam system is not recommended. Tank fabrication is best left to experienced manufacturers since they usually come with a good warranty.

PUMP CHARACTERISTICS

The pump is literally the heart of the wildland fire engine. If its performance is not adequate to serve the needs of the user, the engine will be unsatisfactory even if all other components are suitable. Consider the flow, pressure, and ability to create suction lift and also reliability and maintainability when selecting the pump.

Pumps are either centrifugal or positive displacement. Both types are used in wildland fire fighting equipment, but the centrifugal pump is by far the most popular. The centrifugal pump creates an outward force from a center of rotation (known as the eye) to move or impel water. With these pumps, the volume will vary with speed (rpm) and pressure. Centrifugal pumps are usually larger than positive displacement pumps and are employed for higher volumes.

Positive displacement pumps move a given quantity of water with each stroke or revolution of the piston or impeller. Volume depends mainly on speed (rpm). The rotary gear, vane, cam-and-piston, and rotary piston are typical units. Most are self-priming. Most require relief valves to handle line surges, overloads, and flows not needed at the nozzle. Typical gear pumps have tight tolerances between the rotating parts and the pump housing, which may be damaged by pumping water with impurities such as silt and sand.

PUMP RATINGS

Pumps are rated by the gallons per minute (gpm), at varying psi. Below are NFPA's pump ratings and pressures as are currently (July 2000) being suggested in the draft of "NFPA 1906 Standard for Wildland Apparatus," now being revised. Pump performance on wildland fire apparatus is rated by NFPA as a low-pressure pump, a medium-pressure pump, a high-pressure pump, or an extra-high-pressure pump.

If the pump is rated as a low-pressure pump, it shall flow at one of the following rated capacities at 100-psi net pump pressure: GPM 10, 20, 30, or 50.

If the pump is rated as a medium-pressure pump it shall be capable of delivering one of the rated capacities listed below under the following conditions: GPM 30, 60, 90, 120, 250, 350, 400, or 500.

(a) 100 percent of rated capacity at 150 psi net pump pressure.
(b) 70 percent of the rated capacity at 200 psi net pump pressure.
(c) 50 percent of the rated capacity at 250 psi net pump pressure.

ADDITIONAL INFORMATION ON MAJOR COMPONENTS AND SYSTEMS

If the pump is rated as a high-pressure pump, it shall flow at one of the following rated capacities at 300-psi net pump pressure: GPM 10, 20, 30, 50, 100, or 200.

If the pump is rated as an extra-high-pressure pump, it shall flow at one of the following rated capacities at 400-psi net pump pressure: GPM 10, 20, 30, 50, 100, or 200.

PRIMING SYSTEM

A priming pump is generally necessary to initially evacuate the air and fill a centrifugal pump with the liquid to be pumped. Exhaust, hand, and electric primers are available. There are positive displacement and self-priming centrifugal pumps that do not need a primer. Operator convenience, available mounting space, cost, maintenance requirements, and other factors influence the type of primer selected. Some primers require a primer pump fluid such as oil or antifreeze. Some of these fluids are unacceptable for use in wildland equipment. Pumps that do not require these fluids will not discharge the fluid on to the ground and are preferred.

When a centrifugal pump is full of water, it will create quite a high vacuum; but when the pump has been drained, and contains only air, it will not produce vacuum. To obtain a prime, a vacuum must be created within the pump by some other means. A priming pump is used which should develop a vacuum of at least 17 inches of Hg. The priming pump evacuates air from the fire pump and when connected with a water source is replaced with water.

There are four methods that can be used to prime a centrifugal pump: two that prime consistently and two that do not prime consistently. These methods are shown in table A1.

Table A1—Methods used to prime a centrifugal pump.

Methods that prime consistently
• Priming from the suction with the pump running. • Priming from the discharge with the pump not running.
Methods that DO NOT prime consistently
• Priming from the suction with the pump not running. • Priming from the discharge with the pump running.

The following suggestions should be adhered to for best priming and pump performance when priming from the suction with the pump running:

- A check valve should be used at the discharge of the pump.
- The prime should be taken at the eye of the impeller or at the top of the inlet to the pump.
- A smooth bell-shaped strainer inlet should be used on the end of the suction hose; a foot valve degrades performance.
- For rated pump performance, adequate suction hose size diameter should be used; consult NFPA 1906, Suction Hose Rating Criteria.
- Do not use any longer suction hose than necessary.
- There should be no humps in the suction line. If there are humps in the suction line, a prime or suction should also be taken at the top of the hump as well as at the inlet to the pump.

The following suggestions should be adhered to for best priming and pump performance when priming from the discharge with the pump not running:

- A check valve should be used at the discharge of the pump.

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- The prime should be taken at the high point of the pump discharge and the engine started after pump prime is achieved.
- A smooth bell-shaped strainer inlet should be used on the end of the suction hose; a foot valve degrades performance.
- For rated pump performance, adequate suction hose size diameter should be used; consult NFPA 1906, Suction Hose Rating Criteria.
- Do not use any longer suction hose than necessary.
- Do not allow humps in the suction line.

PTO'S VERSUS AUXILIARY ENGINES

Advantages of a PTO Fire Pump

- Has fewer parts than auxiliary engine driven fire pumps; hence, higher reliability.
- Requires no cabinetry space, allowing more space for water and equipment.
- Weighs less than an auxiliary engine driven fire pump; hence more water or equipment can be carried.
- Hg has no significant loss of pump performance with increase in altitude when a PTO is used to drive the fire pump (because the fire truck chassis engine generally has much more power than required by wildland fire engine pumps).
- Is less costly above about 25–30 hp than the auxiliary fire pump.
- Has no problem with fueling, and no second fuel tank is required if different fuel is used by the auxiliary engine than the chassis.
- Has a lower center of gravity resulting in increased vehicle stability.
- Can be designed so it will make a satisfactory running attack.
- Has a pump suction intake generally lower than found on an auxiliary engine driven pump; hence a higher lift capability when drafting.

Disadvantages of a PTO Fire Pump

- Requires more planning and engineering.
- May be more costly on small performance pumps—25–30 hp and lower.
- May be difficult to fit PTO on low GVWR chassis—12,000 lb GVWR and lower.

Advantages of an Auxiliary Engine Driven Pump

- Makes running attacks at any speed.
- Requires less planning and engineering to integrate into a wildland fire engine than a PTO powered pump.
- Installs and sets up much quicker than a PTO unit.
- Has lower cost for units under 25–30 hp.

Disadvantages of an Auxiliary Engine Driven Pump

- Requires more space than PTO driven pumps, and weighs more than a PTO driven pump.
- Has a loss of pump performance with an increase in altitude.
- Is more costly above about 25–30 hp than a PTO driven unit.
- May require different fuel than chassis; hence requiring two fuel tanks of different fuel types.
- Has a higher center of gravity decreasing vehicle stability if the auxiliary engine and pump are large and heavy.
- Pump suction intake is generally higher than a PTO driven pump; the engine will have less lift capability when drafting.

ADDITIONAL INFORMATION ON MAJOR COMPONENTS AND SYSTEMS

FOAM SYSTEM OR FOAM PROPORTIONING EQUIPMENT

During the last decade, the improved fire extinguishing properties of "Class A" foam have become increasingly recognized. This has resulted in a marked increase in the use of foam to protect natural resources and improvements. When using foam, it is desirable to inject the foam concentrate at a set proportion, regardless of water flow or pressure, directly into the discharge, or high-pressure side of the water pump. There are a number of proportioning systems used to proportion foam concentrate into water streams for use with standard nozzles, aspirating nozzles, or compressed air foam systems (CAFS).

Two basic types of foam concentrate proportioning systems are shown in table A2.

Table A2—Two basic types of foam concentrate proportioning systems.

Manually regulated proportioning systems include
• batch mixing • suction-side proportioner • in-line eductor • variable flow bypass eductor • direct injection, manually regulated
Automatic regulating proportioning systems include
• balanced pressure venturi system a. pump system b. bladder tank systems • water and/or motor meter proportioner • around-the-pump proportioner • direct injection, automatic regulating

The advantage of manually regulated proportioning systems is low initial cost. However, manually regulated proportioning systems (other than batch mixing) have the potential of using more foam concentrate than necessary. This may negate their initial cost savings and become the most costly proportioning system.

Automatic regulating proportioning systems have been designed to remain proportional over a wide range of flows. These systems are not affected by changes in engine pressure, changes in hose length or size, or changes in nozzle adjustments, size, or elevation. Usually they inject the foam concentrate into the discharge side of the pump. Proportioning systems on engines should be tested prior to accepting the unit to ensure they are operating properly.

WEIGHT AND BALANCE

Fire engines are often unique pieces of equipment that are usually built by adding firefighting apparatus to commercial truck chassis. The design limits of the truck chassis are the most important information that the truck manufacturer provides its customer. The fire engine designer and builder must be careful to avoid exceeding the maximum design weight and axle rating of the chassis.

If you plan to use the vehicle off-road for a good percentage of the time, the manufacturers design limits should be reduced since they are based on use on paved highways. Exceeding the chassis manufacturers design limits will cause a vehicle to be out of compliance with federal safety standards, and even worse, to be unsafe. Steering, braking, and stability will be compromised if manufacturers design limits are not heeded. Good examples, along with methodology and tables on how to calculate weight and balance can be found in truck-chassis manufacturer's data books.

Gross Vehicle Weight Rating (GVWR) and Gross Axle Weight Rating (GAWR)

It is a requirement of the National Highway Safety Administration, U.S. Department of Transportation regulations (49 CFR, Part 567—Certification) that the GVWR and GAWR of a vehicle must be posted in the vehicle on a permanently affixed label.

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GVWR is the chassis manufacturer's specified maximum load carrying capacity of a vehicle. The sum of the front GAWR and the rear GAWR for the vehicle can be equal to or greater than the GVWR. However, the in-service weight or "gross vehicle weight" must not exceed 90 percent of the GAWR and GVWR as defined in the requirements of this guide.

It should be noted that the gross vehicle weight includes the complete vehicle with all associated attachments, accessories, payload, crew, and equipment. Experience has shown that over the life of a fire engine, more and more equipment is often added. When specifying a vehicle, it is best to allow for this increase in weight.

GAWR is the chassis manufacturer's specified maximum load carrying capacity of an axle system, as measured at the tire/ground interface. The axle system includes, but is not limited to, the axle, tires, suspension, wheels, frame, brakes, and applied engine torque. The gross axle weights must always be equal to or less than the GVWR. The GVWR cannot be more than the sum of the GVAW, although it may be less, because the frame and other components may not be strong enough to carry the load that the two axles can carry.

Matching Slip-on Units to Chassis

It is essential that slip-on units be matched properly with the truck chassis. To do this, the following information is required: the GVWR, GAWR, curb weight, and axle weights of the truck and the weight and center of gravity of the slip-on unit. Adding the truck and slip-on weights and taking into consideration the crew and equipment, it is easy to determine if the unit will comply with the GVWR. To determine compliance with the GAWR, the center of gravity of the slip-on must be used to calculate the axle loadings. Some slip-on units may have their center of gravity too close to the front of the vehicle, which can cause overloading on the front axle.

Vehicle Stability

Due to the nature of fire engines and the way they are used (FS engines are used in emergency situations, often on rough roads, and in harsh conditions), vehicle stability is extremely important. The height of the center of gravity of the fully equipped and loaded vehicle should be no greater than 75 percent of the rear track width of the vehicle (or chassis manufacturer's guidelines). Rear track width is measured from the center of the rear wheel assembly on one side to the center of the wheel assembly on the other side.

An alternate criteria is to place the fully loaded vehicle on a tilt table. The tilt table should have an aggressive surface and the down slope tires should not be blocked. The vehicle is considered to have adequate stability if the table can be raised to 30 degrees before lifting the front or rear tire.

Vehicle Certification

The final stage manufacturer must affix a permanent certification label or tag that certifies that the unit meets all required federal standards pertaining to the manufacture and completion of the fire apparatus. This is required by CFR 49, Part 567—Certification.

ADDITIONAL RESOURCES FOR DESIGN AND USE INFORMATION

Within the wildland firefighting community, there are a number of groups that are interested in the design and use of fire engines. These groups can be a tremendous resource for those designing and selecting fire engines and associated apparatus.

The FEWT of the NWCG coordinates the fire equipment and fire retardant chemical needs, development, and implementation between Federal and State agencies. FEWT publishes the "Water Handling Equipment Guide." This publication provides photographs and data on a variety of fire engines from Federal and State agencies in the United States. Web site: http://www.nwcg.gov

The Roscommon Equipment Center (REC) is a cooperative program between the National Association of State Foresters and the Michigan Department of Natural Resources. REC develops and tests equipment for wildland fire control. It is located at the

ADDITIONAL INFORMATION ON MAJOR COMPONENTS AND SYSTEMS

Forest Fire Experiment Station, Roscommon, MI. REC specializes in the conversion of U.S. military vehicles to wildland fire suppression units. It also focuses on the equipment development needs of State and local wildfire forces. Web site: http://www.dnr.state.mi.us (Select Divisions, Forest Management, and then Roscommon Equipment Center).

The NFPA is a nonprofit, voluntary membership organization. NFPA's technical actions are focused on facilitating the development and distribution of fire safety codes and standards. Web site: http://www.nfpa.org

NFPA publishes "NFPA 1906, Standard: for Wildland Fire Apparatus," a purchasing standard that specifies the minimum performance characteristics for wildland apparatus (appendix B, figure 5). NFPA revises their standards about every 5 years, and is currently revising "Standard 1906: Wildland Fire Apparatus" published in 1995. The revision is scheduled for completion in 2001.

The SDTDC is staffed with personnel with specialized skills and experience to provide consultation to FS field units. Web site: http://fsweb.sdtdc.wo.fs.fed.us

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VENDORS ON GSA CONTRACT

Since vendor names, addresses, phone numbers, and web sites are constantly changing, we are providing the web site for the list of vendors currently on the GSA contract. By having this direct access you can be assured of having the most current information available.

http://www.gsa.gov then Schedule E Library

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Automatic Regulating Foam Proportioning System. A proportioning system that automatically adjusts the flow of foam concentrate into the water stream to maintain the desired proportioning ratio. These automatic adjustments are made based on changes in water flow or conductivity.

Apparatus. A motor-driven vehicle, or group of vehicles, designed and constructed for the purpose of fighting fires. May be of different types, such as engines, water tenders, etc.

Aspirate (foam). To draw in gases (or other substances)—nozzle-aspirating systems draw air into the nozzle to mix with the foam solution.

Bypass Eductor. An eductor with a bypass around the venturi. This bypass generally has a variable orifice by which the flow rate around the eductor can be controlled.

Balanced Pressure Venturi Foam Proportioning Systems. An automatic regulating proportioning system that employs a venturi, and the water pressure and foam concentrate pressure are equal.

CAFS. A compressed air foam system (CAFS) with: (1) an automatic regulating proportioning system injecting foam concentrate into the discharge or pressure side of the pump, (2) an air compressor injecting air into the discharge or pressure side of the pump, and (3) proper controls and equipment to control the CAFS.

Certification. The final stage manufacturer must affix a permanent certification label, or tag, which certifies that the unit meets all required federal standards pertaining to the manufacture and completion of the fire apparatus. This is required by CFR 49, Part 567—Certification.

Eductor. A device used to introduce and mix fire chemical into a water stream. An eductor is a fitting with three ports: an inlet for water flow, and outlet for water flow, and an inlet for fire chemical concentrate. The flow of water through the eductor produces a region of lower pressure at the fire chemical inlet, drawing the chemical into the water stream.

Foam Concentrate Proportioner Systems. A device or technique used to mix foam concentrate with water to make foam solution.

General Services Administration. An agency of the U.S. Government that includes the Federal Supply Service, the Automated Data and Telecommunications Service, the Public Buildings Service, and the National Archives and Records Service.

Gross Axle Weight Rating (GAWR). The value specified by the manufacturer as the maximum allowable weight placed on an axle of a vehicle when fully equipped, including payload, fluids, and occupants.

Gross Vehicle Weight (GVW). The total weight of the fully equipped, fully loaded vehicle. It includes the weight of the truck and its payload, the weight of the engine fluids, fuel, the driver and passengers—in short, anything and everything part of, contained in, or supported by the vehicle, or simply the inservice weight of the vehicle.

Gross Vehicle Weight Rating (GVWR). The total weight value specified by the manufacturer as the maximum weight of a single motor vehicle.

Incident Command System Classes. Standardized on-scene emergency management classes specifically designed to have wildfire apparatus met the demands of complex single or multiple incidents, with consistency throughout agencies.

National Fire Protection Association (NFPA). Nonprofit educational and technical association formed in 1896, headquartered in Quincy, MA, and devoted to the protection of life and property from fire through development of standards of fire protection and public education.

National Wildfire Coordinating Group (NWCG). A group formed under the direction of the Secretaries of the Interior and Agriculture to improve the coordination and effectiveness of wildland fire activities and provide a forum to discuss, recommend appropriate action, or resolve issues and problems of substantive nature.

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Payload. Weight of passengers and/or cargo being carried by a conveyance.

Priming. Filling pump with water when pump is taking water not under a pressure head. Necessary for centrifugal pumps.

Proportioner. A device that adds a predetermined amount of foam concentrate to water to form foam solution.

Shunt. A parallel or alternative path through which a portion or all of the flow may pass.

Slip-on Units. A self-contained unit including an auxiliary engine driven pump, piping, a tank, and hose storage that is designed to be placed on a truck chassis, utility bed, flat bed, or trailer. These units typically can be placed on and removed from the vehicle with a minimum of time and effort.

Suction Lift. The number of feet (meters) of vertical lift from the surface of the water to the center of the pump impeller.

Water Hammer. A force created by the rapid deceleration of water, commonly created by closing a valve too quickly. Pressures developed in a water hammer, proportional to the mass multiplied by the square of the velocity, can damage a pipe or hose.

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Federal Motor Vehicle Safety Standards. Code of Federal Regulations (CFR) 49, Part 571, Federal Motor Vehicle Safety Standards.

Guidelines for designing wildland fire engines, reformatted for web page August 1998. Northeast Forest Fire Supervisors, in cooperation with Michigan's Forest Fire Experiment Station. Available: http://www.dnr.state.mi.us/www/fmd/ffes/NN3.html News note No. 3.

A discussion of important references and design concerns to help agencies fabricate efficient engines for their fire control needs.

McKenzie, Dan W. 1992. Compressed air foam systems for use in wildland fire applications. San Dimas, CA: U.S. Department of Agriculture, Forest Service, San Dimas Technology and Development Center.13 p.

Report covers equipment arrangements for compressed air foam systems for use in fighting wildland fires.

McKenzie, Dan W. 1992. Proportioners for use in wildland fire applications. San Dimas, CA: U.S. Department of Agriculture, Forest Service, San Dimas Technology and Development Center. 21 p.

Methods of proportioning foam concentrate into water to make foam solution that can be used with standard nozzles, aspirating nozzles, or in a compressed air foam system (CAFS) for use in fighting wildland fires.

McKenzie, Dan W. 1996. Compressed air foam systems (CAFS) for region five water tenders. San Dimas, CA: U.S. Department of Agriculture, Forest Service, San Dimas Technology and Development Center. 17 p.

A response on what type of foam units and equipment should be used on fire prevention patrol engines, and what type of compressed air foam systems should be used on large water tenders (1500 to 3000 gal).

National Wildland Coordinating Group. 1994. Water handling equipment guide. NFES 1275. Boise, ID: U.S. Department of Agriculture, U.S. Department of the Interior, National Association of State Foresters, National Interagency Fire Center. 171 p.

Provide field users in wildland fire fighting agencies with a basic information document on water handling equipment.

National Wildland Coordinating Group. 1994. Wildland fire engine component guide. NFES 1871. Boise, ID: U.S. Department of Agriculture, U.S. Department of the Interior, National Association of State Foresters, National Interagency Fire Center. 112 p.

Specifications to assist wildland fire agencies in the selection of quality components for assembly into fire engines. Provides information on characteristics that should be considered to meet a wide range of wildland fire engine user requirements.

NFPA 1901 Standard for Automotive Fire Apparatus. 1999. National Fire Protection Association. FANS/NFP 1906. Quincy, MA. 148p.

The 1999 edition is a general update of the 1996 edition, which combines four fire apparatus standards designated as NFPA 1901, Standard for Pumper Fire Apparatus; NFPA 1902, Standard for Initial Attack Fire Apparatus; NFPA 1903, Standard for Mobile Water Supply Fire Apparatus; and NFPA 1904, Standard for Aerial Ladder and Elevating Platform Fire Apparatus.

NFPA 1906 Standard for Wildland Fire Apparatus. 1995. National Fire Protection Association, ANS/NFP 1906. Quincy. MA. 58 p.

A standard for apparatus that is basically designed and deployed to combat fire in the wildland.