FS Engine Standardization Appendices
October 29, 2008

Appendix 1

22Oct08

Type 3 Engine Pump Recommendation
Engine Standardization Committee

Recommendation:
We recommend a pump that delivers a minimum of 200 gpm at 300 psi, which is also the recommendation in the Forest Service *Wildland Engine Guide*. A pump meeting these requirements will support three separate 1-1/2 inch hose lays (each flowing water at approximately 65 gpm) at 300 psi. The single stage pump recently tested by SDTDC produced 235 gpm at 300 psi (and 212 gpm at 400 psi) from draft[1], as well as 685 gpm when connected to a municipal fire hydrant.

We recommend that a single stage pump be mated to an automatic transmission with an 10-bolt Power Take-Off (PTO). In addition to providing a robust power-delivery system for the pump, the automatic transmission provides an excellent pump-and-roll platform.

Discussion:
Since one pump will be used nation-wide on standardized Type 3 engines, we carefully attempted to consider the needs of all wildland firefighting scenarios for this specific engine type. The following information was considered during the pump evaluation process.

Current pumps installed on Forest Service (FS) Type 3 engines:
Region 5 has approximately 300 Model 62 engines equipped with Darley JMP500 2-stage centrifugal pumps[2]. Current engines in other regions have a mix of single and 2-stage pumps.

Wildland Fire Hose:
Fire hose is tested at 300 psi during the refurbishment process (and is also the test pressure specified by NFPA). New hose may have an operating pressure greater than 300 psi, but the availability of new hose may be limited.

In terms of friction loss for 1-1/2 inch hose, the practical limit for flow is 75 gpm (approx. 20 psi friction loss per 100 ft). The 1-1/2 inch combination nozzles supplied through GSA (FS spec 5100-239) are rated from 20 to 75 gpm. Therefore, in terms of both friction loss and nozzle flow, a discharge of 75 gpm through 1-1/2 inch hose is a reasonable maximum flow through a single discharge.

Tank Capacity
Tank capacities on FS Type 3 engines range from 500 to 1000 gallons. Flow rate must be considered when pumping directly from the tank as excessively high water delivery rates can deplete a tank in minutes. In Wildland Urban Interface scenarios where a wildland engine may be connected to a hydrant, a high flow pump can be utilized to its potential when multiple hose lays are operated at maximum flow rates.

Powertrain and Pump System:
The chassis engine, transmission, PTO, and pump must be specified and evaluated as a complete "system."

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[1] Drafting conditions: 5 foot lift, 24 ft. of 3-inch suction hose with a suction strainer.
[2] The Darley JMP500 is rated at 500 gpm, but delivers 400 gpm (at 150 psi) as-installed on the Model 62.

SDTDC Testing:
Two late-model Type 3 engines were recently evaluated by SDTDC – a Model 70 (single cab, 600 gallons) equipped with a Hale CBP4[3] single-stage centrifugal pump, and a Model 62 (crew cab, 500 gallons) equipped with a Darley JMP500 2-stage centrifugal pump. Both engines were put in service within the last year.

The Model 62 was tested in "pressure mode" during the drafting tests since Model 62's are rarely operated in "volume mode." Hydrant tests on the Model 62 were performed in both modes in order to provide a more complete comparison with the single-stage pump.

Summary of Hale CBP4 performance[4]:

	Flow		
Pressure	10 ft lift	5 ft lift	Connected to hydrant
100 psi	245 gpm	284 gpm	---
150 psi	230 gpm	274 gpm	458 gpm
200 psi	221 gpm	261 gpm	526 gpm
250 psi	202 gpm	248 gpm	582 gpm
300 psi	190 gpm	235 gpm	635 gpm
350 psi	---	---	685 gpm
400 psi	170 gpm	212 gpm	---

Summary of Darley JMP500 performance:

	Flow		Connected to hydrant	
Pressure	10 ft lift	5 ft lift	pressure mode	volume mode
100 psi	303 gpm	386 gpm	---	---
150 psi	345 gpm	385 gpm	511 gpm	607 gpm
200 psi	347 gpm	385 gpm	486 gpm	678 gpm
250 psi	342 gpm	385 gpm	464 gpm[5]	732 gpm[5]
300 psi	299 gpm	335 gpm	411 gpm	617 gpm
350 psi	---	---	---	---
400 psi	311 gpm	320 gpm	383 gpm	373 gpm

Additional Discussion Regarding High Flow (2-Stage) Pumps:
Negative attributes of the Darley 2-stage pump include higher acquisition cost (greater than $10,000) and maintenance issues (the pump transfer valves are prone to sticking). While there are some limited applications where the 2-stage pump can be utilized to its capability, the increased cost, weight, and maintenance does not appear to justify adopting them as the national standard or offering them as an option.

Finally, the use of a larger pump may affect the fire engine in other ways as foam proportioners designed to work with high flow pumps may not work well (or may not work at all) at flows commonly used in wildland firefighting. Foam delivery to hose reels and small diameter hose may be the most affected.

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[3] The numeral "4" indicates a specific gear ratio for the Hale CBP pump. Several ratios are available.
[4] The model 70 intake plumbing had the equivalent of (9) 90° elbows, which adversely affected pump performance while drafting.
[5] Engine RPM maxed-out at 250 psi, further increase in pumping resistance (pressure) actually decreased flow – as seen by the results for 300 and 400 psi).

Appendix 2
Engine Standards
October 2008

General Requirements:

Certification:	NFPA 1906 (with limited exceptions – separate attachment)
Striping:	per draft FS handbook supplement (based on R-5 requirements)
Color:	Green
Cab configuration:	Single
Foam proportioner:	Automatic-regulating injection on discharge-side of pump

General Options

RLS:	per 5120 and NFPA 1906
Amber lighting:	per NFPA 1906

Specific Requirements by Engine Type:

Type 3 Platform Body

Chassis:	33,000 lb GVWR
Body:	Platform body with storage boxes
Transmission:	Automatic
Tank:	crew cab: 600 gallons; single cab: 750 or 1000 gallons
Pump:	PTO, single stage, 200 gpm @ 300 psi
Panel location:	Rear
Hose reel:	One
Foam capacity:	20 gallons

Options:	Crew cab
	4x2 or 4x4 drive
	Second hose reel
	Spare tire

Type 3 Utility Body

Chassis:	33,000 lb GVWR
Body:	Utility body
Transmission:	Automatic
Tank:	crew cab: 600 gallons; single cab: 750 or 1000 gallons
Pump:	PTO, single stage, 200 gpm @ 300 psi
Panel location:	Rear
Hose reel:	One
Foam capacity:	20 gallons

Options:	Crew cab
	4x2 or 4x4 drive
	Second hose reel
	Spare tire

Type 4 Platform Body

Chassis:	33,000 lb GVWR
Body:	Single Cab, Platform body with storage boxes
Tank:	750 gallons or 850 gallons (single cab only)
Pump:	Auxiliary engine, 50 gpm @ 250 psi
Panel location:	Rear
Hose reel:	One
Foam capacity:	20 gallons
Options:	Extended or crew cab
	4x2 or 4x4 drive
	Automatic or manual transmission
	Second hose reel

Type 4 Utility Body

Chassis:	33,000 lb GVWR
Body:	Single Cab, Utility body
Tank:	750 gallons or 850 gallons (single cab only)
Pump:	Auxiliary engine, 50 gpm @ 250 psi
Panel location:	Rear
Hose reel:	One
Foam capacity:	20 gallons
Options:	Extended or crew cab
	4x2 or 4x4 drive
	Automatic or manual transmission
	Second hose reel

Type 6 Platform Body

Chassis:	17,950 lb GVWR
Drive:	4x4
Body:	Extended Cab, Platform body with storage boxes
Tank:	300 gallons
Pump:	Auxiliary engine, 50 gpm @ 250 psi
Panel location:	Rear
Hose reel:	One
Foam capacity:	20 gallons
Options:	Single or crew cab
	Automatic or manual transmission
	Second hose reel

Type 6 Utility Body

Chassis:	17,950 lb GVWR
Drive:	4x4
Body:	Extended Cab, Utility body
Tank:	300 gallons
Pump:	Auxiliary engine, 50 gpm @ 250 psi
Panel location:	Rear
Hose reel:	One
Foam capacity:	20 gallons
Options:	Single or crew cab
	Automatic or manual transmission
	Second hose reel

Type 7 Slip-on unit

Tank:	50 or 125 gallons
Pump:	Auxiliary gas engine, 10 gpm @ 100 psi
Hose reel or basket:	One
Options:	50 or 125 gallons
	Foam proportioner

Installation requirements:	50 gal: 9,700 lb GVWR min
	125 gal: 12,000 lb GVWR min

Note: A Type 5 engine was not proposed because there are a limited number currently in service.

Appendix 3
Model Naming Convention

3 digit engine designation for engine Types 3, 4 and 6:

Digit:	Designates:	Possibilities:
First:	NWCG engine type	3, 4, or 6
Second:	Drive	"2" = 4x2, "4" = 4x4
Third:	Body	"P" = platform body, "U" = utility body

Model:	Engine Type	Drive	Body
32P	3	4X2	Platform Body
32U	3	4X2	Utility Body
34P	3	4X4	Platform Body
34U	3	4X4	Utility Body
42P	4	4X2	Platform Body
42U	4	4X2	Utility Body
44P	4	4X4	Platform Body
44U	4	4X4	Utility Body
64P	6	4X4	Platform Body
64U	6	4X4	Utility Body

3 digit engine designation for engine Type 7:

Digit:	Designates:	Possibilities:
First:	NWCG engine type	7
Second:	Tank size	"S" = 50 gal, "L" = 125 gal
Third:	Configuration	"S" = slip-on unit

Model:	Engine Type	Tank	Configuration
7SS	7	50 gal	Slip-on
7LS	7	125 gal	Slip-on

2 digit engine designation for Tactical Water Tenders Types 1 and 2

Digit:	Designates:	Possibilities:
First:	NWCG WT type	1 or 2
Second:	Drive	"2" = 4x2, "4" = 4x4

Model:	WT Type	Drive
12	1	4X2
14	1	4X4
22	2	4X2
24	2	4X4

Appendix 4
Engine Identification System

Unit designator:

AA-BBB

Where:

AA = State
BBB = 3 alpha forest designator

Example: AZ-CNF = Arizona (R-3), Coronado National Forest

Equipment designator:

WXYZ

Where:

W = equipment category (E = Engine, P = Prevention, D = Dozer, etc)
X = equipment type (Type 3, Type 7, etc.)
Y = district
Z = equipment number

Example: E312 = engine, type 3, district 1, engine number 2

Complete example:

AZ-CNF-E312

Appendix 5
Fire Engine Marking Standard
October 2008

Markings Based on Green Paint Color for Engines
(Will be adjusted if white is allowed)

ROOF:
Standard White Reflective 18" on Green Engine or

SIDE:
4" White Reflective Stripe (Series 680-10) cut at 45° angle to allow for
4" FIRE decal White Reflective;
6" Forest ID White Reflective and
8" Engine No. White Reflective placed on lower rear of crew door

DOOR DECAL:
10" FS Shield White with Brown border/lettering
7/16" FOR OFFICIAL USE ONLY
5/8" U.S. GOVERNMENT
1 ½" Equipment No.
All reflective vinyl. Placed middle of door below stripe

REAR:
3" U.S.D.A. FOREST SERVICE
4" FIRE Decal
6" Forest ID and Engine No.
White Reflective

FRONT:
6" Forest ID and Engine No.
White Reflective