



SEDONA FIRE DISTRICT

STANDARD OPERATING PROCEDURE #356

Annual Service Tests of Fire District Pumps on Fire Apparatus

I. Purpose.

This SOP provides the necessary information and forms needed to perform the required testing of fire district pumping apparatus.

II. Scope.

This SOP applies to all operational personnel.

III. Policy.

Annual service tests are required on all apparatus with an NFPA rated fire pump with a capacity of 250 gpm or greater. This would include all SFD pumpers, aerials and water tenders, but not a Type 6 brush truck. Additional tests will be performed any time a pump is disassembled for repairs, and when deemed necessary by the Fleet Supervisor. Annual Service Tests shall be scheduled according to the Operations Chief or his designee. Tests shall be performed during normal weekday business hours, when possible, to increase the likelihood that a mechanic is available if a mechanical problem arises. An Engineer normally assigned to the apparatus being tested shall be present during the test whenever possible.

IV. Procedure.

- A. All tests shall be documented on the provided form included with this document. Thorough documentation ensures that a reliable performance history can be established. Incomplete forms will be returned to the sender before starting any test, a copy of the previous year's test should be reviewed, and referred to when necessary. Temperatures, pressures, nozzle sizes, and hose layouts shall be consistent.
- B. *Testing Equipment.* Equipment furnished at the testing site will include the pump testing unit (vacuum, pressure and pitot gauges, and air hose and accessories), a flow measuring kit, hand counter for checking RPMs, thermometer, master stream, and other miscellaneous tools. Each engine company will use and test its own hard suction hose (20'), as well as provide the necessary lengths of fire hose required to achieve the desired flow rates. Prior to the year's first tests, the Operations Chief, or his designee, shall ensure that the testing pit is in good repair, and the quality of the test pit water is clean, chlorinated to prevent, and free from any, coliforms or acidic properties.
- C. *Testing Site.* The test pit is located on the East side of Station #1, in the administration parking lot. Care should be taken to avoid any parking issues before the start of any testing. The Engineer will schedule the test to ensure that the ambient temperature is no greater than 100° F and that the temperature of the test pit water is within the range of 35° to 90°F. Prior to the start of the day's first tests, the Engineer shall check the water with a ph strip to ensure that it is non-acidic, so as to provide protection to the crew and equipment.
- D. The test pit water shall be kept constantly filled no less than 4' deep.
- E. *Safety Considerations.* All personnel will wear a minimum of gloves, helmet, and hearing protection. Do not stand over the top of pressurized hoses. Cover the opening to the test pit. Open and close all valves slowly, and manipulate the throttle slowly to prevent water hammer.

and damage to hoses and apparatus. Apparatus wheels shall be properly chocked upon arrival, and shall remain throughout the entire test.

- F. *Other Considerations:* The test pit is located within close proximity to a private business (restaurant). Employees are reminded to avoid performing tests during the “lunch hour” (1100 to 1300 Hours) and shall take care to prevent any noisy testing during that time.
- G. Procedure:
1. Position and secure the apparatus safely, with access to the test pit, and install the air hoses to the pump panel and ports on the test gauges.
 2. *Engine-Driven Accessories.* All headlights, warning lights, running lights, and air conditioners shall be running during the pumping portion of the tests.
 3. *Engine Speed Check.* The Engineer shall verify the governed engine speed is with +/- 50 RPM of the governed engine speed at the time the engine was new. Any discrepancies shall be corrected before continuing.
 4. *Vacuum Test.* The integrity of the pump shall be checked as follows:
 - a. Completely drain the pump.
 - b. Connect 20' of hard suction and put a cap on the end.
 - c. All other intakes shall be open and capped, and all discharge caps removed.
 - d. The primer shall be operated according to manufacturers instructions.
 - e. The maximum vacuum attained shall be no less than 20in. Hg.
 - f. The vacuum shall not drop more than 10 in. Hg in 5 minutes.
 - g. The primer shall not be used again once the 5 minute test period has begun.
 - h. The engine shall not be operated at any speed greater than the governed engine speed.
 - i. Vacuum failures shall always be documented and reported to the Fleet Supervisor, but should not necessarily be grounds to discontinue the service test. Small vacuum leaks are common, and will not affect the outcome of the water flow portions of the test. In the event that NO vacuum can be obtained (even for a few seconds) , immediately stop the test and inform the Fleet Supervisor or Operations
 5. *Priming Device Test.* A priming test will be performed on all apparatus.
 - a. Setup sufficient hose for the pumping tests (See Table 1).
 - b. Ensure that a sufficient amount of primer oil (if used) is in the oil reservoir.
 - c. Install a strainer on the end of the hard suction and place the end in the test pit.
 - d. Ensure that the end of the hard suction is surrounded with a minimum of 2 feet of water.
 - e. Operate the primer. The interval from the time the primer is started until the time the pump is discharging water shall be noted.
 - f. The time required to prime the pump shall not exceed 30 seconds if the rated capacity is 1250 gpm or less, and 45 seconds if the rated capacity is 1500 gpm or greater.
 6. *Pumping Test.* Pumps will be tested at the rated capacity at 150 psi for twenty minutes, 70% of capacity at 200 psi for 10 minutes, and 50% of capacity at 250 psi for 10 minutes.
 - a. Determine the required Net Discharge Pressure according to the lift, suction size, and friction loss in the suction. (See Table 2)
 - b. Increase pump speed until the net discharge pressure is 150 psi. If the pump is a two-stage pump, it shall be in the Volume/Parallel mode.

- c. Check the flow at the nozzle. If the flow is too great, close a valve further. Readjust (lessen) engine speed to decrease the pressure. If the flow is too low, open a valve further and readjust (increase) engine speed.
 - d. When both the pump discharge pressure and the volume flowing are satisfactory, the test officially begins. The following information will be recorded at 5 minute intervals on the Pump Test Record:
 - 1. Pump Discharge Pressure
 - 2. Nozzle Pressure (Pitot)
 - 3. Engine Tachometer
 - 4. Tachometer with portable rpm counter (where possible)
 - 5. Any significant changes to oil pressure, coolant temperature and automatic transmission fluid temperature should also be documented in the notes section of the form.
 - e. Once the 20-minute test has been completed, and while the pump is still operating at capacity, the operator will immediately perform the Overload Test.
 - f. *Overload Test.* Set the pressure control device (if equipped) to 165 psi, increase engine speed to 165 psi and pump the rated capacity for 5 minutes.
 - g. Return the pressure control device (if equipped) to the 150 psi and decrease engine speed to 150 psi. Close each valve, one at a time, in no less than 3 seconds and no greater than 10 seconds. *Note: Pumps that are not equipped with a manual pressure control device have an electronic pressure governor, and still need to be overload tested.*
 - h. The pump discharge pressure shall rise no more than 30 psi. Record the maximum pressure attained.
 - i. Open the valves and return to the pump to capacity flow at 150 psi. Reduce the pressure to 90 psi and set the pressure control device (if equipped) and repeat the valve closing procedure.
 - j. Once again, the rise in pressure shall not exceed 30 psi. Document the results.
 - k. Change the tip to achieve the required flow for the 70% of capacity test. Set any two-stage pump to *either* Volume or Pressure.
 - l. Document the required information for the 70% test every three minutes.
 - m. Change the tip to achieve the desired flow for the 50% capacity test. Set any two-stage pump to Pressure.
 - n. Document the required information for the 50% capacity test every three minutes.
 - o. Upon completing the 50% capacity test the final pressure control test will be performed.
 - p. Continue flowing 50% of capacity and set the pressure control device for 250 psi. Close the valves as before and document the maximum attained pressure. Again, pressure shall increase no more than 30 psi.
7. *Tank to Pump Flow Test.* This test is performed on all apparatus equipped with a water tank, regardless of size. The purpose of this test is to ensure that the piping between the water tank and the pump are sufficient to supply the required flow.
- a. Pumps with a capacity of 500 gpm or less must flow at least 250 gpm from the tank. Pumps with a capacity greater than 500 gpm must flow a minimum of 500 gpm from the tank.
 - b. Make sure the water tank is completely full.
 - c. Close the tank fill line and all pump intakes.

- d. Attach sufficient hoselines and nozzles to achieve the desired discharge flow rate.
- e. Open the discharge(s) and begin flowing water.
- f. Increase the engine throttle until the maximum consistent pressure is obtained on the discharge pressure gauge.
- g. Immediately close the discharge valve, *without changing the throttle setting*, and refill the tank. The bypass valve may be opened to prevent overheating.
- h. Reopen the discharge valve and check the flow with a pitot or other means. Adjust the throttle if necessary. The desired flow must be maintained until at least 80% of the capacity of the tank has been emptied. If the flow rate cannot be achieved there is a problem in the tank-to-pump line.

H. Documentation

- 1. Complete the SFD Pump Test Record in its entirety. The goal of this testing program is not only to provide a thorough test, but to accurately document the results so we can establish pump histories based on fact. Incomplete records will be returned to the responsible Engineer and the test may be rescheduled if enough documentation is not provided.
- 2. Forward the test results to the Operations Chief's designee responsible for scheduling the pump testing.
- 3. The Operations Chief's designee will transfer the appropriate information to Firehouse.

The following pages are the attached forms and tables used in this procedure.

EFFECTIVE DATE: 3/16/07

FIRE CHIEF: Original signed by Matt Shobert

REPLACES: New

Table 1

Hose Layouts for Pump Tests
All hose is 2 1/2" diameter unless otherwise specified

Pump Capacity in GPM's	Hose and Nozzle Layout
250-350	One 50-foot line with a 1 1/8" or 1 1/4" nozzle
400-500	One 50-foot line with a 1 3/8" or 1 1/2" nozzle
600-750	Two 100-foot lines with a 1 1/2" or 1 3/4" nozzle
1000	Two or three 100-foot lines with a 2" nozzle
1250	Two 100-foot 3" lines and one 50-foot 3" line with a 2 1/4" nozzle
1500	Three 100-foot 3" lines with a 2 1/2" nozzle

Table 2**Friction Loss in 20' of Intake Hose, Including Strainer**

*Figures in parenthesis indicate increment to be added for each 10 ft. of hose greater than 20 ft.

Flow GPM	4"	4 ½"	5"	6"
350	2.5 (0.7)			
245	1.2 (0.3)			
175	0.7 (0.1)			
450	4.1 (1.0)	2.7 (0.4)		
315	2.0 (0.5)	1.2 (0.2)		
225	1.0 (0.2)	0.6 (0.1)		
500	5.0 (1.3)	3.6 (0.8)	2.1 (0.4)	0.9 (0.2)
350	2.5 (0.7)	1.8 (0.4)		
250	1.3 (0.4)	0.9 (0.3)		
600	7.2 (1.8)	5.3 (1.0)	3.1 (0.6)	
420	3.5 (1.0)	2.5 (0.5)	1.6 (0.3)	
300	1.8 (0.4)	1.3 (0.2)	0.6 (0.1)	
700	9.7 (2.7)	7.3 (1.3)	4.3 (0.8)	1.7 (0.3)
490	4.9 (1.1)	3.5 (0.7)	2.0 (0.4)	
350	2.5 (0.7)	1.6 (0.3)	0.9 (0.2)	
750	11.4 (2.9)	8.0 (1.6)	4.7 (0.9)	1.9 (0.4)
525	5.5 (1.5)	8.9 (0.8)	2.3 (0.5)	0.9 (0.2)
375	2.8 (0.7)	2.0 (0.4)	1.2 (0.2)	0.5 (0.1)
1000		14.5 (2.8)	8.4 (1.6)	3.4 (0.6)
1250			13.0 (2.4)	5.2 (0.9)
875			6.5 (1.2)	2.6 (0.5)
625			3.3 (0.7)	1.3 (0.3)
1500				7.6 (1.4)
1050				3.7 (0.7)
1225				5.0 (0.9)
875				2.6 (0.5)



Service Test Record

Date: _____ Apparatus: _____ AZ Plate #: _____

Manufacturer: _____ Year Manufactured: _____

Model: _____ Serial Number: _____

Engine Make: _____ Engine Model: _____

Pump Make: _____ Pump Model: _____

Pump Capacity: _____ 70% Capacity: _____ 50% Capacity _____

Speed Check Taken From: _____ Ratio to Engine: _____

Test Site Location: Sedona Fire District Station One Elevation: 4400'

Air Temperature: _____ Water Temperature: _____

Suction Hose Size: _____ Length: _____ Lift: _____

Governed Engine Speed: _____ Maximum Engine Speed Attained: _____

Maximum Vacuum Attained: _____ Vacuum Drop in 5 Minutes: _____

Time to Prime Pump: _____

Pressure Control Test:

Rise While Pumping Capacity at 150 psi: _____

Rise While Pumping 70% Capacity at 200 psi: _____

Rise While Pumping 50% Capacity at 250 psi: _____

Tank-to-Pump Water Flow Test: _____

Corrected Gauge Pressure Calculations:

Capacity _____ GPM Lift _____ + FL _____ ÷ 2.3 = _____ (a) 150 - (a) = _____ PSIG

70% _____ GPM Lift _____ + FL _____ ÷ 2.3 = _____ (a) 200 - (a) = _____ PSIG

50% _____ GPM Lift _____ + FL _____ ÷ 2.3 = _____ (a) 250 - (a) = _____ PSIG

Pump Test Summary

Duration	Average Nozzle Pressure	Corrected Pressure	GPM	Average Pump Pressure	RPM Engine	RPM Pump
20 Min						

Notes: _____

Theoretical Discharge Through Circular Orifices Gallons Per Minute

Pitot	Velocity Discharge Feet per Second	Diameter of Orifice (Inches)						
		1 1/8"	1 1/4"	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"
1	12.20	37.8	46.7	67.2	91.4	119	151	187
2	17.25	53.4	66	95	129	169	214	264
3	21.13	65.4	80.8	116	158	207	239	302
4	24.39	75.6	93.3	134	183	239	302	373
5	27.26	84.5	104	150	204	267	338	417
6	29.87	92.5	114	164	224	292	370	457
7	32.26	99.9	123	178	242	316	400	494
8	34.49	107	132	190	259	338	427	528
9	36.58	113	140	201	274	358	453	560
10	38.56	119	148	212	289	378	478	590
11	40.45	125	155	223	303	396	501	619
12	42.24	131	162	233	317	414	524	646
13	43.97	136	168	242	330	431	545	673
14	45.63	141	175	251	342	447	566	698
15	47.22	146	181	260	354	463	586	722
16	48.78	151	187	269	366	478	605	746
17	50.28	156	192	277	377	493	623	769
18	51.73	160	198	285	388	507	642	791
19	53.15	165	203	293	399	521	659	813
20	54.54	169	209	300	409	534	676	834
22	57.19	177	219	315	429	560	709	875
24	59.74	185	229	329	448	585	741	914
26	62.18	193	238	343	466	609	771	951
28	64.52	200	247	356	484	632	800	987
30	66.79	207	256	368	501	654	828	1022
32	68.98	214	264	380	517	676	856	1055
34	71.1	220	272	392	533	697	882	1088
36	73.16	226	280	403	548	717	908	1119
38	75.17	233	288	414	563	736	932	1150
40	77.11	239	295	425	578	755	956	1180
42	79.03	245	303	435	592	774	980	1209
44	80.88	251	310	445	606	792	1003	1237
46	82.70	256	317	455	620	810	1025	1265
48	84.48	262	324	465	633	828	1047	1293
50	86.22	267	330	475	646	845	1069	1319
52	87.93	272	337	485	659	861	1091	1345
54	89.61	277	343	494	672	878	1111	1371
56	91.2	283	350	503	684	894	1132	1396

Pitot	Velocity Discharge Feet per Second	Diameter of Orifice (Inches)						
		1 1/8"	1 1/4"	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"
58	92.87	288	356	512	696	909	1152	1421
60	94.45	293	362	520	708	925	1171	1445
62	96.01	297	368	529	720	941	1191	1470
64	97.55	302	374	538	731	956	1210	1493
68	100.55	311	385	554	754	985	1247	1539
70	102.03	316	391	562	765	999	1265	1561
72	103.47	320	396	570	776	1014	1283	1583
74	104.90	325	402	578	786	1028	1301	1605
76	106.30	329	407	586	797	1041	1318	1627
78	107.69	333	412	593	807	1055	1335	1648
80	109.08	338	418	601	818	1068	1352	1669
82	110.42	342	423	608	828	1082	1369	1689
84	111.76	346	428	616	838	1095	1386	1710
86	113.08	350	433	624	848	1107	1402	1730
88	114.39	354	438	630	858	1120	1419	1750
90	115.68	358	443	637	867	1133	1434	1770
92	116.96	362	448	644	877	1146	1450	1789
94	118.23	366	453	651	886	1158	1466	1809
96	119.48	370	457	658	895	1170	1481	1828
98	120.71	374	462	665	904	1182	1497	1847
100	121.94	378	467	672	914	1194	1512	1866
102	123.15	381	472	679	923	1206	1527	1884
104	124.35	385	476	685	932	1218	1542	1903
106	125.55	389	481	692	941	1230	1556	1921
108	126.73	392	485	698	950	1241	1571	1939
110	127.89	396	490	705	959	1253	1586	1957
112	129.05	400	494	711	967	1264	1600	1974
114	130.20	403	499	717	976	1275	1614	1992
116	131.33	407	503	724	984	1286	1628	2009
118	132.46	410	507	730	993	1297	1642	2027
120	133.57	414	512	736	1001	1308	1656	2044
122	134.69	417	516	742	1010	1319	1670	2061
124	135.79	421	520	748	1018	1330	1684	2077
126	136.88	424	524	754	1026	1341	1697	2094
128	137.96	427	528	760	1034	1351	1711	2111
130	139.03	431	532	766	1042	1362	1724	2127
132	140.10	434	536	772	1050	1372	1736	2144
134	141.16	437	540	777	1058	1382	1749	2160
136	142.21	441	544	783	1066	1392	1762	2176

Notes:
