FIRE APPARATUS DRIVER/OPERATOR 1B

Approved and Adopted by the
Office of State Fire Marshal

Recommended for adoption by the Statewide
Training and Education Advisory Committee
and the
State Board of Fire Services

STUDENT SUPPLEMENT

October 2008

FIRE APPARATUS DRIVER/OPERATOR 1B

PUMP OPERATIONS

STUDENT SUPPLEMENT

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Mission Statement

The mission of State Fire Training is to enable the California fire service to safely protect life and property through education, training, and certification.

California Fire Service Training and Education System

The California Fire Service Training and Education System (CFSTES) was established to provide a single statewide focus for fire service training in California. CFSTES is a composite of all the elements that contribute to the development, delivery, and administration of training for the California Fire Service. The authority for the central coordination of this effort is vested in the Training Division of the California State Fire Marshal's Office with oversight provided by the State Board of Fire Services.

The role of CFSTES is one of facilitating, coordinating, and assisting in the development and implementation of standards and certification for the California fire service. CFSTES manages the California Fire Academy System by providing standardized curriculum and tests; accredited courses leading to certification; approved standardized training programs for local and regional delivery; administering the certification system; and publishing Career Development Guides, Instructors Guides, Student Manuals, Student Supplements, and other related support materials.

This system is as successful and effective as the people involved in it are. It is a fire service system developed by the fire service, for the fire service... and we believe it is the best one in the country.

Acknowledgments

State Fire Training coordinated the development of the material contained in this guide. Before its publication, the Statewide Training and Education Advisory Committee (STEAC) and the State Board of Fire Services (SBFS) recommended this guide for adoption by the State Fire Marshal (SFM). This guide is appropriate for fire service personnel and for personnel in related occupations that are pursuing State Fire Training certification.

Ruben Grijalva Director of CAL FIRE	
Kate Dargan State Fire Marshal	**Tonya Hoover** Assistant State Fire Marshal
Mike Richwine Chief, State Fire Training	**Ronny Coleman** Chair, STEAC

Special acknowledgement and thanks are extended to the following members of State Fire Training for their diligent efforts and contributions that made the final publication of this document possible.

Alicia Hamilton Fire Service Training Specialist III

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We gratefully acknowledge the following individuals who served as principal developers for this document.

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"We gratefully acknowledge the hard work and accomplishments of those before us who built the solid foundation on which this program continues to grow."

Course Outline

Course Objectives: To…

a) Provide students with information on pump construction and theory of pump operations.

b) Provide students with methods for performing basic hydraulics.

c) Provide students with information and techniques on basic inspections, documentation, maintenance, and troubleshooting fire pumps.

d) Provide students with the opportunity to increase their pumping skills during simulated pumping conditions.

Texts and References

- Driver Operator Training Program, Modesto Regional Training Center, Modesto Junior College, 2002 Edition
- Engineer Training Program, Tiburon Fire District, 2001 Edition
- Fire Apparatus Driver/Operator 1B Student Supplement, SFT, 2008 Edition
- Fire Fighting Hydraulics, Purington, First Edition
- Fire Service Instructor's Manual, Waterous Pump Company, 1996 Edition
- NFPA 1002: Standard for Fire Apparatus Driver/Operator Professional Qualifications, 2009 Edition
- NFPA 1451: Standard for a Fire Service Vehicle Operations Training Program, 2007 Edition
- NFPA 1500: Standard on Fire Department Occupational Safety and Health Program, 2007 Edition

- NFPA 1582: Standard on Comprehensive Occupational Medical Program for Fire Departments, 2007 Edition
- NFPA 1901: Standard for Automotive Fire Apparatus, 2009 Edition
- NFPA 1911: Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus, 2007 Edition
- Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition
- Title 49 CFR Transportation, U.S. Government Printing Office, October 2006 Edition
- Type III Training Manual, Rincon Valley Fire District, 2002 Edition

Calendar of Events

DAY	TOPIC	TITLE	TIME	ACTIVITY	EVALUATION
Day 1	1-1	Orientation And Administration	1:30	1-1-1	
	1-2	Fire Apparatus Driver/Operator Responsibilities	0:30		
	2-1	Types Of Fire Pumps	0:45		
	2-2	Pump Mounting And Drive Arrangements	0:30		
	2-3	Pump Piping And Valves	0:15		
	2-4	Automatic Pressure Control Devices	0:15		
	2-5	Priming Devices	0:15		
	2-6	Pump Panel Instrumentation	0:15		
	2-7	Auxiliary Cooling Devices	0:15		
	3-1	Basic Hydraulic Terminology And Symbols	0:30		
	3-2	Mathematics Review	1:00	3-2-1	
	3-3	Characteristics Of Water And Principles of Pressure	0:30		
	3-4	Principle Features Of Water Systems	0:15		
	3-5	Nozzle Theory	0:30		
	3-6	Calculating Gallons Per Minute	0:30	3-6-1	
	3-7	Principles Of Friction Loss	0:15		
		Day 1 Total	**8:00**		
Day 2	3-8	Friction Loss Formulas And Calculations	4:00	3-8-1	
	3-9	Pump Discharge Pressure	0:30	3-9-1	
			1:00		**Test 1**
	3-10	Fireground Hydraulic Calculations	1:00	3-10-1	
	4-1	Inspecting The Pump Drive Systems	0:15		
	4-2	Inspecting The Priming Pump Systems	0:15		
	4-3	Inspecting The Pump Pressure Control Systems	0:15		
	4-4	Pump Service Testing	0:45		
		Day 2 Total	**8:00**		
Day 3	4-5	Maintenance Of The Pump And Control Systems	1:00		
			0:30		**Test 2**
	5-1	Making The Pump Operational (From Tank)	0:30		
	5-2	Transitioning To An External Water Supply	0:30		
	5-3	Operating From A Hydrant	0:30		
	5-4	Principles And Practices Of Drafting Operations	0:30		
	5-5	Principles Of Relay Pump Operations	1:30		
	5-6	Troubleshooting Pump Operations	1:00	5-6-1	
	5-7	Principles Of Tandem Pumping Operations	0:15		
	5-8	Principles Of Dual Pumping Operations	0:15		
	5-9	Principles And Practices Of Foam Operations	1:00		
	5-10	Sprinkler And Standpipe Support	0:30		

DAY	TOPIC	TITLE	TIME	ACTIVITY	EVALUATION
		Day 3 Total	**8:00**		
Day 4			0:30		**Test 3**
	6-1	Introduction To The Mandatory Pumping Exercises	0:30		
		Operating From Draft Exercise	7:00	6-1-1	
		Operating Using A Forward Lay Exercise		6-1-2	
		Operating Using A Reverse Lay Exercise		6-1-3	
		Day 4 Total	**8:00**		
Day 5		Practice Pumping Exercises	6:00		
		Graded Exercises		Performance Exams	
		Review And Certification Exam	2:00	Certification Exam	
		Day 5 Total	**8:00**		

*Mandatory Pumping Exercises

Topic 1-1: Orientation and Administration

Student information for this topic can also be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 1-10.

Course Prerequisites

- ❒ California driver's license. You must bring your license to the instructor for verification.
  - Class B.
  - Fire fighter restricted (minimum).
- ❒ Fire Fighter I training recommended.

Student Evaluation

- ❒ Activities.
  - Complete all activities.
- ❒ Three written unit tests.
  - Each followed with group discussion.
  - All tests must be completed and passed with a minimum score of 80%.
  - Tests must be returned to the instructor after review.
- ❒ Pumping exercises.
  - Manipulative skills tracking and accountability.
  - Minimum score of 80% required to pass each mandatory manipulative performance test.
- ❒ Progress chart.
- ❒ State certification exam.
  - Not related to final course grade.
  - Must pass the class first before taking the exam.
  - 50 question multiple-choice exam.
  - Minimum 70% required to pass the certification exam.

Course Description

- ❒ 40-hour class.
  - Classroom information and activities.
  - Reading assignments.
  - Apparatus inspection.
  - Hands-on pumping exercises.

- ❒ Identify start and end times.
  - Class will begin on time.
  - Student attendance requirements.
    - Must attend the entire course.
    - Excused absences may be considered for emergencies.
- ❒ Proper attire.
  - Classroom.
    - Station wear or equivalent.
    - Station boots or equivalent.
  - Field exercises.
    - Station wear or equivalent.
    - Station boots or equivalent.
    - Helmet.
    - Gloves.
- ❒ Required textbooks.
  - Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition
  - State Fire Training student supplement

Course Objectives

Provide the students with…

- ❒ Information on pump construction and theory of pump operations.
- ❒ Information on methods for performing basic hydraulics.
- ❒ Information and techniques on basic inspections, documentation, maintenance, and troubleshooting fire pumps.
- ❒ The opportunity to increase their pumping skills during simulated pumping conditions.

Historical Overview

The first course, and foundation, of the current Fire Apparatus Driver/Operator certification program was titled Driver/Operator I and II. This course was first offered through the California State Fire Marshal's Office in September 1982. The program consisted of sixteen 8-hour classes that had to be completed to receive California State Fire Marshal certification. The course objectives and direction was based upon the career development guide, derived from the California Fire Service Occupational Analysis. Also used as a reference and basis of the course objectives was the National Fire Protection Association (NFPA) Pamphlet 1002 titled: Fire Apparatus Driver/Operator Professional Qualifications.

Since the inception of the Driver/Operator I and II courses, the demands and expectations placed upon the fire service and the professional apparatus driver/operator have greatly increased. Legal, ethical, and operational responsibilities have grown in dimension, requiring several revisions and modifications to the

original Driver/Operator I and II. This most recent redesign of the fire apparatus driver/operator curriculum encompasses these new and critical responsibilities, while maintaining the foundation of the original Driver/Operator I and II programs. The intent of this course is to maintain the highest level of ability, skills, and integrity of the professional fire apparatus driver/operator, while preparing all personnel to face the ongoing challenges of their profession.

Desirable Skills

The following skills and senses have been found to be critical to be a successful driver/operator:

- ❑ Reading ability: for understanding all laws, signs, and relevant memos/orders.
- ❑ Writing ability: clearly and concisely for documentation and reporting.
- ❑ Mathematical ability: basic algebra skills necessary for hydraulics.
- ❑ Physical fit: high demands both physical and mental.
- ❑ Hearing and vision: as required by law and department standards.
- ❑ Mechanical ability: A critical skill of the professional driver/operator. If Plan A fails, what is Plan B? If Plan B fails, what is Plan C, and so on?
- ❑ Basis supervisory skills: If the company officer is injured or unavailable, it may be necessary for the fire apparatus driver/operator to make officer-level decisions.
- ❑ Have the ability to remain calm, think, and make decisions under pressure.
- ❑ Must have the ability to avoid "tunnel vision," always be aware of surroundings and the entire situation.
- ❑ Have the ability to identify safety hazards.

National Fire Protection Association Standards

The following information is paraphrased from the actual code. The standard listing is in a priority order for this program.

NFPA 1002: Standard For Fire Apparatus Driver/Operator Professional Qualifications

- ❒ Chapter 1: Administration.
- ❒ Chapter 4: General Requirements.
- ❒ Chapter 5: Apparatus Equipped with a Fire Pump.
- ❒ Appendix A: Explanatory Material.

NFPA 1915: Standard For Fire Apparatus Preventive Maintenance Program

- ❒ Chapter 1: Administration.
- ❒ Chapter 4: General Requirements.
- ❒ Chapter 6: Out-of-Service Criteria.

- ❒ Chapter 9: Inspection and Maintenance of Water Pumping Systems and Water Tanks.
- ❒ Chapter 11: Inspection and Maintenance of Foam Proportioning Systems.
- ❒ Chapter 12: Inspection and Maintenance of Compressed Air Foam Systems (CAFS).
- ❒ Chapter 18: Performance Testing of Fire Pumps and Industrial Supply Pumps.
- ❒ Chapter 20: Performance Testing of Foam Proportioning Systems.
- ❒ Chapter 21: Performance Testing of Compressed Air Foam Systems (CAFS).
- ❒ Appendix A

NFPA 1451: Standard For A Fire Service Vehicle Operations Training Program

- ❒ Chapter 1: Administration.
- ❒ Chapter 4: General Rules and Considerations.
- ❒ Chapter 5: Training and Education.
- ❒ Chapter 6: Laws and Liabilities.
- ❒ Chapter 10: Vehicle and Apparatus Care.

NFPA 1500: Standard for Fire Department Occupational Safety and Health Program

- ❒ Chapter 6: Fire Apparatus, Equipment, and Driver/Operators.

INDIVIDUAL ACTIVITY 1-1-1

TITLE:	Basic Math Skills
TIME FRAME:	0:30
MATERIALS NEEDED:	• Calculator • Square root chart • Pen or pencil
INTRODUCTION:	This activity provides you the opportunity to become familiar with or sharpen your math skills as they relate to fire hydraulics.
DIRECTIONS:	1. Complete Sections I, II, III, and IV. 2. You have 15 minutes to complete this activity. 3. Be prepared to discuss your answers with the class.

SECTION I: CALCULATE THE FOLLOWING EQUATIONS

Whole Numbers

1. 18426 + 21575 _____
2. 95360 – 77469 _____
3. 156 x 38 _____
4. (128)(15) _____
5. 352 ÷ 32 _____
6. 4410/21 _____

Decimals

7. 34.3 + 18.66 _____
8. 29.05 – 6.1 _____
9. 34.3 x 3.3 _____
10. (2124.002)(10) _____
11. 36.3 ÷ 3.3 _____
12. 2124.002/10 _____

Fractions

13. $^1/_4 + {}^1/_2$ _____
14. $^1/_4 - {}^1/_8$ _____
15. $^3/_4 \times {}^1/_2$ _____
16. $^1/_4 \div {}^1/_2$ _____

Percentages

17. 10% of 100 _____
18. 15% of 200 _____
19. $^3/_8 =$ _____% _____

Proportion

What is the value of x?

20. $\frac{1}{2} = \frac{2}{x}$ _____

Square Root

21. $\sqrt{9}$ _____
22. $\sqrt{15}$ _____
23. $\sqrt{50}$ _____
24. $\sqrt{246}$ _____

Numbers Squared

25. 7^2 _____
26. 12^2 _____
27. 16^2 _____
28. 46^2 _____
29. 112^2 _____

SECTION II: CONVERT THE FOLLOWING FRACTIONS TO A DECIMAL

30. $^{3}/_{8}$ _____
31. $^{5}/_{8}$ _____
32. $^{1}/_{16}$ _____
33. $^{3}/_{4}$ _____
34. $^{2}/_{3}$ _____

SECTION III: CALCULATE THE AREA OF EACH CIRCLE

Round your answer to the nearest whole number.

35. Diameter = 6 feet _____
36. Diameter = 8 feet _____
37. Diameter = 14 feet _____
38. Diameter = 28 feet _____
39. Radius = 16 feet _____

SECTION IV: CALCULATE THE CAPACITY OF EACH CYLINDER TANK (IN GALLONS)

Round your answer to the nearest whole number.

40. Diameter = 3 feet
    Length = 14 feet _____
41. Diameter = 10 feet
    Length = 12 feet _____
42. Diameter = 15 feet
    Length = 40 feet _____
43. Diameter = 20 feet
    Length = 4 feet _____
44. Diameter = 25 feet
    Length = 8 feet _____

SQUARE ROOTS OF NUMBERS 1-250

n	$\sqrt{n}$	n	$\sqrt{n}$	n	$\sqrt{n}$	n	$\sqrt{n}$	n	$\sqrt{n}$
1	1.000	51	7.1414	101	10.0499	151	12.2882	201	14.1774
2	1.414	52	7.2111	102	10.0995	152	12.3288	202	14.2127
3	1.732	53	7.2801	103	10.1489	153	12.3693	203	14.2478
4	2.000	54	7.3485	104	10.1980	154	12.4097	204	14.2829
5	2.236	55	7.4163	105	10.2470	155	12.4499	205	14.3178
6	2.449	56	7.4833	106	10.2956	156	12.4900	206	14.3527
7	2.646	57	7.5498	107	10.3441	157	12.5300	207	14.3875
8	2.828	58	7.6158	108	10.3923	158	12.5698	208	14.4222
9	3.000	59	7.6811	109	10.4403	159	12.6095	209	14.4568
10	3.162	60	7.7460	110	10.4881	160	12.6491	210	14.4914
11	3.3166	61	7.8102	111	10.5357	161	12.6886	211	14.5258
12	3.4641	62	7.8740	112	10.5830	162	12.7279	212	14.5602
13	3.6056	63	7.9373	113	10.6301	163	12.7671	213	14.5945
14	3.7417	64	8.0000	114	10.6771	164	12.8062	214	14.6287
15	3.8730	65	8.0623	115	10.7238	165	12.8452	215	14.6629
16	4.0000	66	8.1240	116	10.7703	166	12.8841	216	14.6969
17	4.1231	67	8.1854	117	10.8167	167	12.9228	217	14.7309
18	4.2426	68	8.2462	118	10.8628	168	12.9615	218	14.7648
19	4.3589	69	8.3066	119	10.9087	169	13.0000	219	14.7986
20	4.4721	70	8.3666	120	10.9545	170	13.0384	220	14.8324
21	4.5826	71	8.4261	121	11.0000	171	13.0767	221	14.8661
22	4.6904	72	8.4853	122	11.0454	172	13.1149	222	14.8997
23	4.7958	73	8.5440	123	11.0905	173	13.1529	223	14.9332
24	4.8990	74	8.6023	124	11.1355	174	13.1909	224	14.9666
25	5.0000	75	8.6603	125	11.1803	175	13.2288	225	15.0000
26	5.0990	76	8.7178	126	11.2250	176	13.2665	226	15.0333
27	5.1962	77	8.7750	127	11.2694	177	13.3041	227	15.0665
28	5.2915	78	8.8318	128	11.3137	178	13.3417	228	15.0997
29	5.3852	79	8.8882	129	11.3578	179	13.3791	229	15.1327
30	5.4772	80	8.9443	130	11.4018	180	13.4164	230	15.1658
31	5.5678	81	9.0000	131	11.4455	181	13.4536	231	15.1987
32	5.6569	82	9.0554	132	11.4891	182	13.4907	232	15.2315
33	5.7446	83	9.1104	133	11.5326	183	13.5277	233	15.2643
34	5.8310	84	9.1652	134	11.5758	184	13.5647	234	15.2971
35	5.9161	85	9.2195	135	11.6190	185	13.6015	235	15.3297
36	6.0000	86	9.2736	136	11.6619	186	13.6382	236	15.3623
37	6.0828	87	9.3274	137	11.7047	187	13.6748	237	15.3948
38	6.1644	88	9.3808	138	11.7473	188	13.7113	238	15.4272
39	6.2450	89	9.4340	139	11.7898	189	13.7477	239	15.4596
40	6.3246	90	9.4868	140	11.8322	190	13.7840	240	15.4919
41	6.4031	91	9.5394	141	11.8743	191	13.8203	241	15.5242
42	6.4807	92	9.5917	142	11.9164	192	13.8564	242	15.5563
43	6.5574	93	9.6437	143	11.9583	193	13.8924	243	15.5885
44	6.6332	94	9.6954	144	12.0000	194	13.9284	244	15.6205
45	6.7082	95	9.7468	145	12.0416	195	13.9642	245	15.6525
46	6.7823	96	9.7980	146	12.0830	196	14.0000	246	15.6844
47	6.8557	97	9.8489	147	12.1244	197	14.0357	247	15.7162
48	6.9282	98	9.8995	148	12.1655	198	14.0712	248	15.7480
49	7.0000	99	9.9499	149	12.2066	199	14.1067	249	15.7797
50	7.0711	100	10.0000	150	12.2474	200	14.1421	250	15.8114

Topic 1-2: Fire Apparatus Driver/Operator Responsibilities

Student information for this topic can also be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 1-20, 31-54, 99-131.

Fire Fighter Injury and Death Statistics

According to NFPA statistics, the second leading cause of on-duty deaths to fire fighters is vehicle crashes and collisions. Of the 102 total "Line of Duty Deaths" of fire fighters in 2007, 20 deaths occurred in collisions or rollovers. Whether responding to an emergency incident, or in nonemergency status, safety for fire service personnel and civilians alike is of paramount importance. Not only is it the responsibility of the fire apparatus driver/operator to observe and enforce all safety issues, it is the responsibility of all fire service personnel to watch for any possible safety hazards.

Safety

Safety is of the highest importance in every aspect of our profession. Regardless of whether you are responding to, or involved in, an active emergency incident, or merely in the nonemergency status, we all must be alert to any possible hazard. As a fire apparatus driver/operator, your primary responsibility and obligation to prevent any injury from occurring to both fire service and nonfire service personnel occurs in several areas.

- ❒ Prior to leaving the fire station.
  - All personnel must be seated, with seat belts on.
  - All cords and attachments to apparatus are removed.
  - Apparatus bay doors are completely opened.
  - Apparatus compartment doors are closed.
  - All equipment is properly stored and removed from apparatus area.
  - Proper apparatus checks have been performed.
- ❒ Driving status.
  - Always drive in the defensive mode.
  - Observe all laws and regulations related to the safe operation of fire apparatus.
  - Use a spotter whenever backing up or when proceeding forward, if necessary.
    - Spotters should always remain in the view of the driver/operator, either by line of sight or by mirror.

Apparatus Placement and Operation

Scene hazards include:

- ❒ Possible building collapse.

- ❒ Electrical or wire hazards.
- ❒ Passing vehicles.
- ❒ Ground integrity.
- ❒ Civilian or emergency personnel.
- ❒ Other emergency vehicle placement.
- ❒ Weather and topography.

Other Responsibilities

A critical responsibility of the fire apparatus driver/operator is knowledge of your emergency response district. Time is of essence in any emergency, as is safety. A thorough knowledge of your response district, including traffic thoroughfares, traffic habits and hazards, will reduce critical minutes from the overall response time. Other points of importance include, but are not limited to:

- ❒ Hydrant locations and any unusual hydrants, such as a dead-end main.
- ❒ High life hazards such as, hospitals, low- and high-rise residential care homes, etc.
- ❒ High hazard facilities such as, chemical storage, radiation, high storage, etc.
- ❒ Access problems such as narrow roads, setbacks, loading zones, etc.
- ❒ Operation of pumps and associated components to produce and maintain effective fire streams.

Topic 2-1: Types of Fire Pumps

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 266-281.

Topic 2-2: Pump Mounting and Drive Arrangements

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 280-285.

Topic 2-3: Pump Piping and Valves

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 285-293.

Topic 2-4: Automatic Pressure Control Devices

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 293-298.

Topic 2-5: Priming Devices

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 298-301.

Topic 2-6: Pump Panel Instrumentation

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 301-307.

Topic 2-7: Auxiliary Cooling Devices

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 307-309.

Topic 3-1: Basic Hydraulic Terminology and Symbols

Student information for this topic can also be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 571-587.

Terminology

Appliance Loss ..... (AL) Portion of pressure lost when water flows through an appliance; friction loss.

Area ..... (A) Surface measurement; noted as a squared linear measurement such as square inches.

Atmospheric Pressure ..... Weight of the air or atmosphere (14.7 psi at sea level). Pressure gauge that reads zero is actually 14.7 psi.

Cavitation ..... The formation of a vacuum around a propeller or fan revolving at a speed above a certain critical value. Vacuum pockets form in a pump and cause vibrations, loss of efficiency.

Circumference ..... (c) The distance around the outside of a circle. If the circumference were stretched out in a straight line, it would be 3.14 times as long as the diameter.

Coefficient ..... (C) Number assigned to a math equation.

Constant ..... A fixed value assigned to a mathematical equation.

Critical Velocity ..... The friction loss becomes so great that the entire stream is agitated by the resistance and causes turbulence. At this point, it becomes necessary to parallel lines to reduce the friction.

Diameter ..... (d) The distance from one edge of a circle to the other, passing through the center.

Elevation Pressure ..... (EP) Gain or loss of pressure in a hoseline due to change in elevation. The pressure lost from overcoming the effects of forcing water above the level of the pump discharge.

Flow Pressure .....(FP) Forward velocity pressure measured at a discharge opening. Can be measured with a pitot tube and gauge.

Friction Loss..... (FL) That part of the total pressure lost while forcing water through pipe, fittings, hoselines, adapters, and appliances. Varies with the type of construction and shape of pipe, fittings, hoselines, adapters, and appliances.

Gallons Per Minute.....(gpm) Measurement of water flow. Volume per time measurement.

Head Pressure ..... Water pressure due to elevation. Measured from the surface of the water source to the discharge orifice (0.434 psi per foot of elevation).

Height.....(h) Measurement of elevation above a given point.

Hydraulics ..... The science that treats the mechanics of fluid at rest and in motion.

Lift..... Elevation difference between the surface of the static water source and the eye of the pump impeller. Distance from the surface of the water to the center of the pump.

Net Pump Discharge Pressure ..... (NPDP) Actual amount of pressure being produced by the pump.

Normal Operating Pressure..... Pressure normally found in a water distribution system during normal consumption demands.

Nozzle Pressure .....(NP) Pressure of the water discharged at the nozzle.

Nozzle Reaction.....(NR) Counterforce directed against a person holding a nozzle.

Pi.....(π) The constant derived from the length of the circumference of a circle (3.14 times the length of the diameter). Used as part of the formula to determine the volume of a round area.

Pressure.....(P) Has a variety of meanings, but generally defined as the force per unit area, measured in pounds per square inch (psi).

Pump Discharge Pressure.....(PDP) Pressure of the water as it leaves the pump.

Radius..... r The distance from the outer edge of the circle to the center of the circle.

Residual Pressure..... Remaining water pressure while water is flowing (left over); available pressure. Measured at compound gauge with water flowing.

Specific Gravity.....(sg) The weight of a substance compared with the weight of an equal volume of water.

Square Root .....(√) A given number multiplied by itself.

Static Pressure..... Water pressure that is not flowing (standing still). Stored potential energy to force water through pipe, hoselines, and fittings.

Suction (Draft) ..... Process of taking water from static sources located below the level of the fire apparatus by exhausting the air from the pump chamber and using atmospheric pressure to force water through the suction hose and into the pump.

Total Pressure Loss .....(TPL) The amount of pressure loss due to total friction loss and elevation pressure loss

Vacuum ..... Any pressure below atmospheric pressure; a negative pressure. Usually indicated in inches of mercury (in. Hg).

Velocity..... The speed of travel. Linear measurement per time measurement. Measured in feet per seconds (fps) or miles per hour (mph).

Volume ..... (V) Measurement of cubic scale in a container. Noted as a cubed linear measurement and measured in cubic inches.

Water Flow..... Measurement in gallons per minute (gpm).

Water Hammer ..... Force created by the sudden deceleration or acceleration of water caused by the sudden opening or closing of nozzles or valves. Has damaging effects to hoselines, water mains, hydrants, fire pumps and related accessories, piping, life safety; sudden, violent jerking of hoselines and possible rupturing creates extreme, unsafe conditions.

Quick Reference Chart – Hydraulic Symbols

π 3.14

AL ..... appliance loss

A ..... area

c ..... circumference

C ..... coefficient

d ..... diameter

EP ..... elevation pressure

fps ..... feet per second

FP ..... flow pressure

FL ..... friction loss

gpm ..... gallons per minute

G ..... gravity

h ..... height

in. Hg ..... inches in mercury

L ..... length

LL ..... length of line

NPDP ..... net pump discharge pressure

NP ..... nozzle pressure

NR ..... nozzle reaction

psi ..... pounds per square inch

psig ..... pounds per square inch gauge

P ..... pressure

PDP ..... pump discharge pressure

Q ..... quantity of water

r ..... radius

sg ..... specific gravity

√ ..... square root

TPL ..... total pressure loss

V ..... volume

Topic 3-2: Mathematics Review

INDIVIDUAL ACTIVITY 3-2-1

TITLE:	Mathematics Review
TIME FRAME:	0:15
MATERIALS NEEDED:	• Square root chart • Calculator • Pen or pencil
INTRODUCTION:	This activity provides you the opportunity to reference and sharpen your math skills as they relate to fire hydraulics.
DIRECTIONS:	1. Complete Sections I through V. 2. You have 10 minutes to complete this activity. 3. Be prepared to discuss your answers with the class.

SECTION I: CALCULATE THE FOLLOWING SQUARE ROOTS

1. $\sqrt{8}$ _____
2. $\sqrt{20}$ _____
3. $\sqrt{100}$ _____
4. $\sqrt{300}$ _____

SECTION II: SQUARE THE FOLLOWING NUMBERS

5. 6^2 _____
6. 9^2 _____
7. 18^2 _____
8. 101^2 _____

SECTION III: CONVERT THE FOLLOWING FRACTIONS TO A DECIMAL

9. 7/8 _____
10. 1/8 _____
11. 1/4 _____
12. 1/2 _____

SECTION IV: CALCULATE THE AREA OF EACH CIRCLE

Round your answer to the nearest whole number. πr^2)

13. Radius = 2 feet _____
14. Radius = 10 feet _____
15. Radius = 15 feet _____
16. Radius = 20 feet _____

SECTION V: CALCULATE THE CAPACITY OF EACH CYLINDER TANK

Round your answer to the nearest whole number. ($d^2 6L$)

17. Diameter = 2 feet
    Length = 14 feet _____
18. Diameter = 10 feet
    Length = 10 feet _____
19. Diameter = 15 feet
    Length = 3 feet _____
20. Diameter = 20 feet
    Length = 5 feet _____

SQUARE ROOTS OF NUMBERS 1-250

n	$\sqrt{n}$	n	$\sqrt{n}$	n	$\sqrt{n}$	n	$\sqrt{n}$	n	$\sqrt{n}$
1	1.000	51	7.1414	101	10.0499	151	12.2882	201	14.1774
2	1.414	52	7.2111	102	10.0995	152	12.3288	202	14.2127
3	1.732	53	7.2801	103	10.1489	153	12.3693	203	14.2478
4	2.000	54	7.3485	104	10.1980	154	12.4097	204	14.2829
5	2.236	55	7.4163	105	10.2470	155	12.4499	205	14.3178
6	2.449	56	7.4833	106	10.2956	156	12.4900	206	14.3527
7	2.646	57	7.5498	107	10.3441	157	12.5300	207	14.3875
8	2.828	58	7.6158	108	10.3923	158	12.5698	208	14.4222
9	3.000	59	7.6811	109	10.4403	159	12.6095	209	14.4568
10	3.162	60	7.7460	110	10.4881	160	12.6491	210	14.4914
11	3.3166	61	7.8102	111	10.5357	161	12.6886	211	14.5258
12	3.4641	62	7.8740	112	10.5830	162	12.7279	212	14.5602
13	3.6056	63	7.9373	113	10.6301	163	12.7671	213	14.5945
14	3.7417	64	8.0000	114	10.6771	164	12.8062	214	14.6287
15	3.8730	65	8.0623	115	10.7238	165	12.8452	215	14.6629
16	4.0000	66	8.1240	116	10.7703	166	12.8841	216	14.6969
17	4.1231	67	8.1854	117	10.8167	167	12.9228	217	14.7309
18	4.2426	68	8.2462	118	10.8628	168	12.9615	218	14.7648
19	4.3589	69	8.3066	119	10.9087	169	13.0000	219	14.7986
20	4.4721	70	8.3666	120	10.9545	170	13.0384	220	14.8324
21	4.5826	71	8.4261	121	11.0000	171	13.0767	221	14.8661
22	4.6904	72	8.4853	122	11.0454	172	13.1149	222	14.8997
23	4.7958	73	8.5440	123	11.0905	173	13.1529	223	14.9332
24	4.8990	74	8.6023	124	11.1355	174	13.1909	224	14.9666
25	5.0000	75	8.6603	125	11.1803	175	13.2288	225	15.0000
26	5.0990	76	8.7178	126	11.2250	176	13.2665	226	15.0333
27	5.1962	77	8.7750	127	11.2694	177	13.3041	227	15.0665
28	5.2915	78	8.8318	128	11.3137	178	13.3417	228	15.0997
29	5.3852	79	8.8882	129	11.3578	179	13.3791	229	15.1327
30	5.4772	80	8.9443	130	11.4018	180	13.4164	230	15.1658
31	5.5678	81	9.0000	131	11.4455	181	13.4536	231	15.1987
32	5.6569	82	9.0554	132	11.4891	182	13.4907	232	15.2315
33	5.7446	83	9.1104	133	11.5326	183	13.5277	233	15.2643
34	5.8310	84	9.1652	134	11.5758	184	13.5647	234	15.2971
35	5.9161	85	9.2195	135	11.6190	185	13.6015	235	15.3297
36	6.0000	86	9.2736	136	11.6619	186	13.6382	236	15.3623
37	6.0828	87	9.3274	137	11.7047	187	13.6748	237	15.3948
38	6.1644	88	9.3808	138	11.7473	188	13.7113	238	15.4272
39	6.2450	89	9.4340	139	11.7898	189	13.7477	239	15.4596
40	6.3246	90	9.4868	140	11.8322	190	13.7840	240	15.4919
41	6.4031	91	9.5394	141	11.8743	191	13.8203	241	15.5242
42	6.4807	92	9.5917	142	11.9164	192	13.8564	242	15.5563
43	6.5574	93	9.6437	143	11.9583	193	13.8924	243	15.5885
44	6.6332	94	9.6954	144	12.0000	194	13.9284	244	15.6205
45	6.7082	95	9.7468	145	12.0416	195	13.9642	245	15.6525
46	6.7823	96	9.7980	146	12.0830	196	14.0000	246	15.6844
47	6.8557	97	9.8489	147	12.1244	197	14.0357	247	15.7162
48	6.9282	98	9.8995	148	12.1655	198	14.0712	248	15.7480
49	7.0000	99	9.9499	149	12.2066	199	14.1067	249	15.7797
50	7.0711	100	10.0000	150	12.2474	200	14.1421	250	15.8114

Topic 3-3: Characteristics of Water and Principles of Pressure

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 135-161.

Topic 3-4: Principle Features of Water Systems

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 151-161 and 325.

Topic 3-5: Nozzle Theory

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 165-179.

Topic 3-6: Calculating Gallons per Minute

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 166 and 179.

INDIVIDUAL ACTIVITY 3-6-1

TITLE:	Calculating Nozzle and Hydrant gpm
TIME FRAME:	0:20
MATERIALS NEEDED:	• Pen or pencil
INTRODUCTION:	This activity provides you the opportunity to calculate gpm for nozzles and hydrants in a step-by-step format using standard formulas.
DIRECTIONS:	1. Calculate the gpm for each of the following using the appropriate formula. 2. You have 15 minutes to complete this activity. 3. Be prepared to discuss your answers with the class.

NOZZLES

1. Nozzle = $1^{1}/_{8}$" tip and NP of 60 psi
   gpm = $(29.7)(d^2 \times \sqrt{NP})$ _____
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____

2. Nozzle = 1" tip and NP of 50 psi
   gpm = $(29.7)(d^2 \times \sqrt{NP})$ _____
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____

3. Nozzle = 1¼" tip and NP of 50 psi
   gpm = $(29.7)(d^2 \times \sqrt{NP})$
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____

4. Nozzle = 1½" tip and NP of 80 psi
   gpm = $(29.7)(d^2 \times \sqrt{NP})$
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____

5. Nozzle = 1¾" tip and NP of 80 psi
   gpm = $(29.7)(d^2 \times \sqrt{NP})$
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____

6. Nozzle = $^7/_8$" tip and NP of 50 psi
   gpm = $(29.7)(d^2 \times \sqrt{NP})$
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____

HYDRANTS

7. Hydrant = .7 coefficient, 2½" outlet, and FP of 43 psi
   gpm = (29.7)[c x (d^2 x √ FP)]
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____

8. Hydrant = .8 coefficient, 2½" outlet, and FP of 90 psi
   gpm = (29.7)[c x (d^2 x √ FP)]
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____

9. Hydrant = .7 coefficient, 2½" outlet, and FP of 86 psi
   gpm = (29.7)[c x (d^2 x √ FP)]
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____
   gpm = _____

10. Hydrant = .9 coefficient, 2½" outlet, and FP of 75 psi
    gpm = (29.7)[c x (d^2 x √ FP)]
    gpm = _____
    gpm = _____
    gpm = _____
    gpm = _____
    gpm = _____

Topic 3-7: Principles of Friction Loss

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 147-150.

Topic 3-8: Friction Loss Formulas and Calculations

Student information for this topic can also be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 185-209.

FRICTION LOSS COEFFICIENT DETERMINATION CHART

Date: **11/06/2002** Hose Size: **1¾"** Hose Construction: **Double jacket, rubber lined**

Person(s) Conducting The Tests: **R. Confer, G. Bryant, T. Hostetter, D. Ockey**

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9
Test Run #	Pump Discharge Pressure psi	Pressure @ Gauge 1 psi	Pressure @ Gauge 2 psi	Nozzle Pressure* psi	Flow from Flow meter or by Equation**	$\left(\frac{gpm}{100}\right)^2$ or $\left(\frac{Col\ 6}{100}\right)^2$	Friction Loss per 100 feet or $\left(\frac{Col\ 3 - Col\ 4}{2}\right)$	C $\left(\frac{Col\ 8}{Col\ 7}\right)$
1	40	30	15	8	n/a	$\left(\frac{106}{100}\right)^2$ 1.12	7.5	6.29
2	180	150	50	30	n/a	$\left(\frac{205}{100}\right)^2$ 4.20	50	11.90
3	115	100	35	20	n/a	$\left(\frac{168}{100}\right)^2$ 2.82	32.5	11.52
4								

*Not necessary if flow meter is used
**gpm = 29.7 d^2 √NP

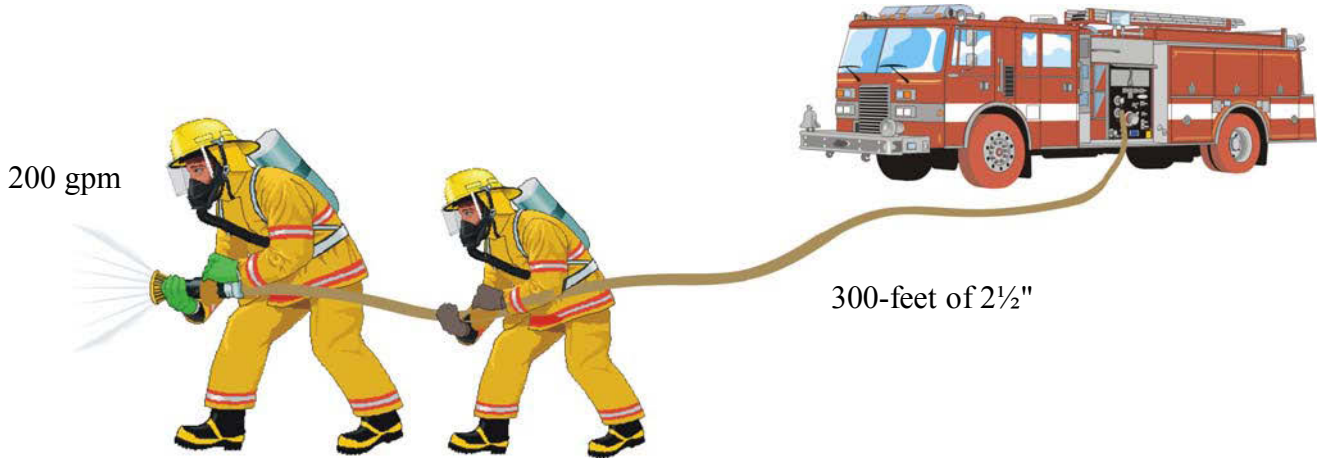
Average C =	Total of all Column 9 answers ***29.71***
	# of tests conducted
Average C =	***9.90***

INDIVIDUAL ACTIVITY 3-8-1

TITLE:	Calculating Friction Loss
TIME FRAME:	0:15
MATERIALS NEEDED:	• Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 142-146 • Pen or pencil
INTRODUCTION:	This activity provides you the opportunity to become familiar with and sharpen your calculating skills as they relate to friction loss formulas.
DIRECTIONS:	1. Calculate the friction loss for the following scenarios. 2. You have 10 minutes to complete this activity. 3. Be prepared to discuss your answers with the class.

SECTION I: SIMPLE HOSE LAYS

1. Find the correct friction loss.



FL = $(C \times Q^2)(L)$

C = _____

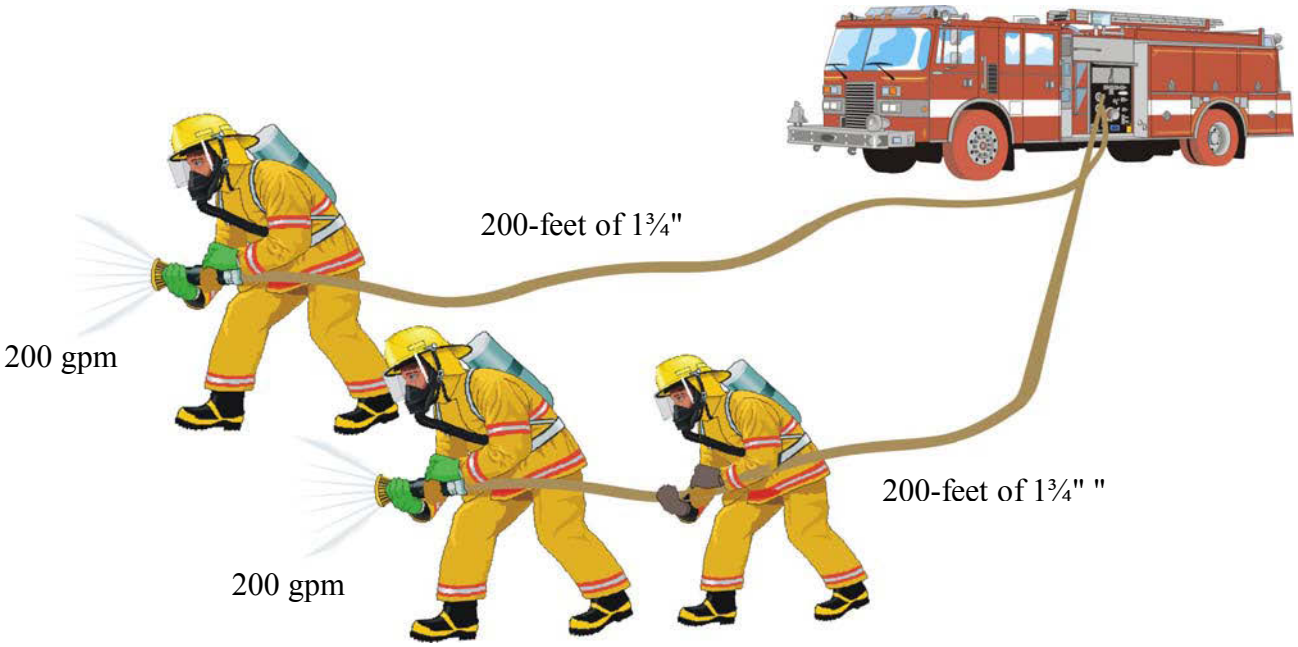
Q = _____

L = _____

FL = _____

FL = _____

2. Find the correct friction loss.



FL = $(C \times Q^2)(L)$

C = _____

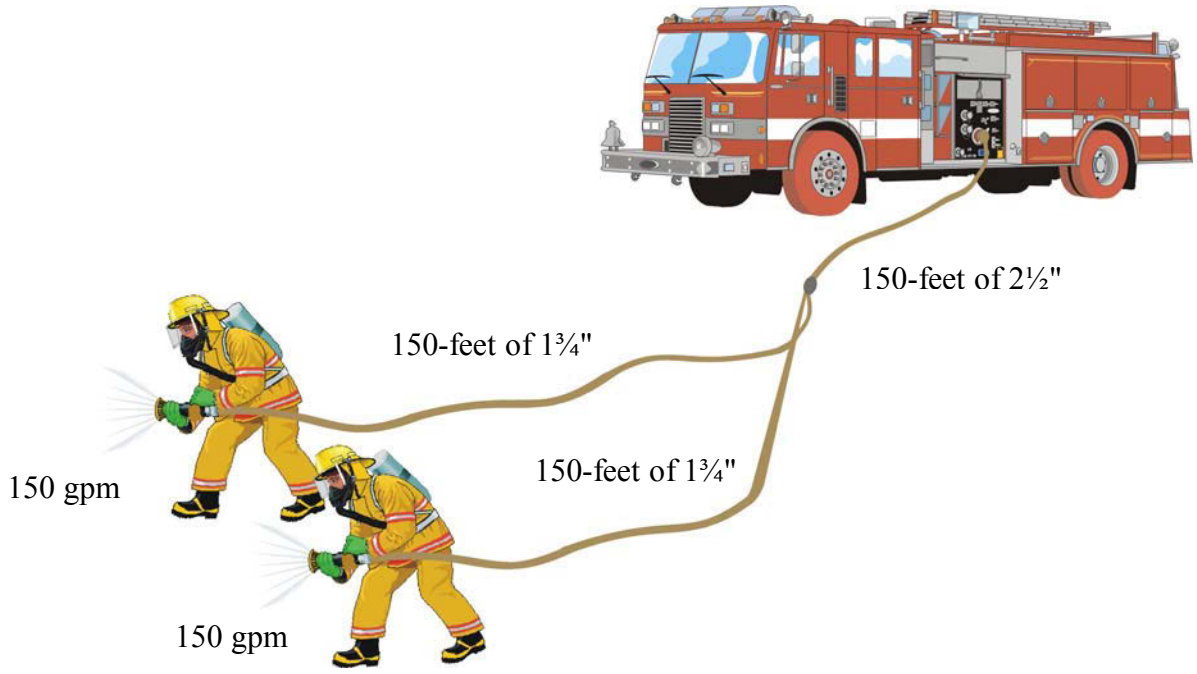
Q = _____

L = _____

FL = _____

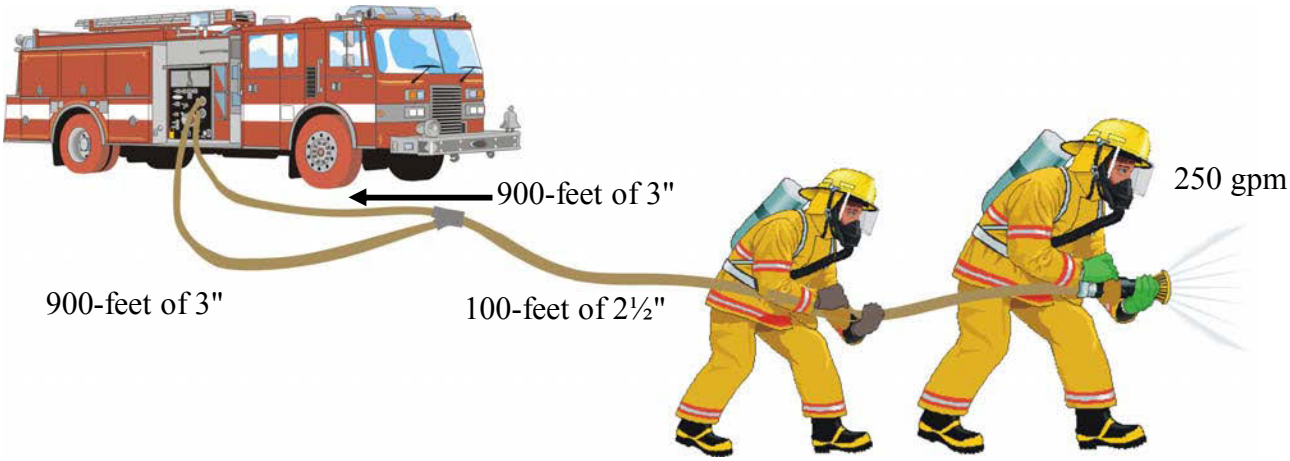
FL = _____

3. Find the correct friction loss.



2½" Line:	Wye Line:
FL = $(C \times Q^2)(L)$	FL = $(C \times Q^2)(L)$
C =	C =
Q =	Q =
L =	L =
FL =	FL =
FL =	FL =

4. Find the correct friction loss.

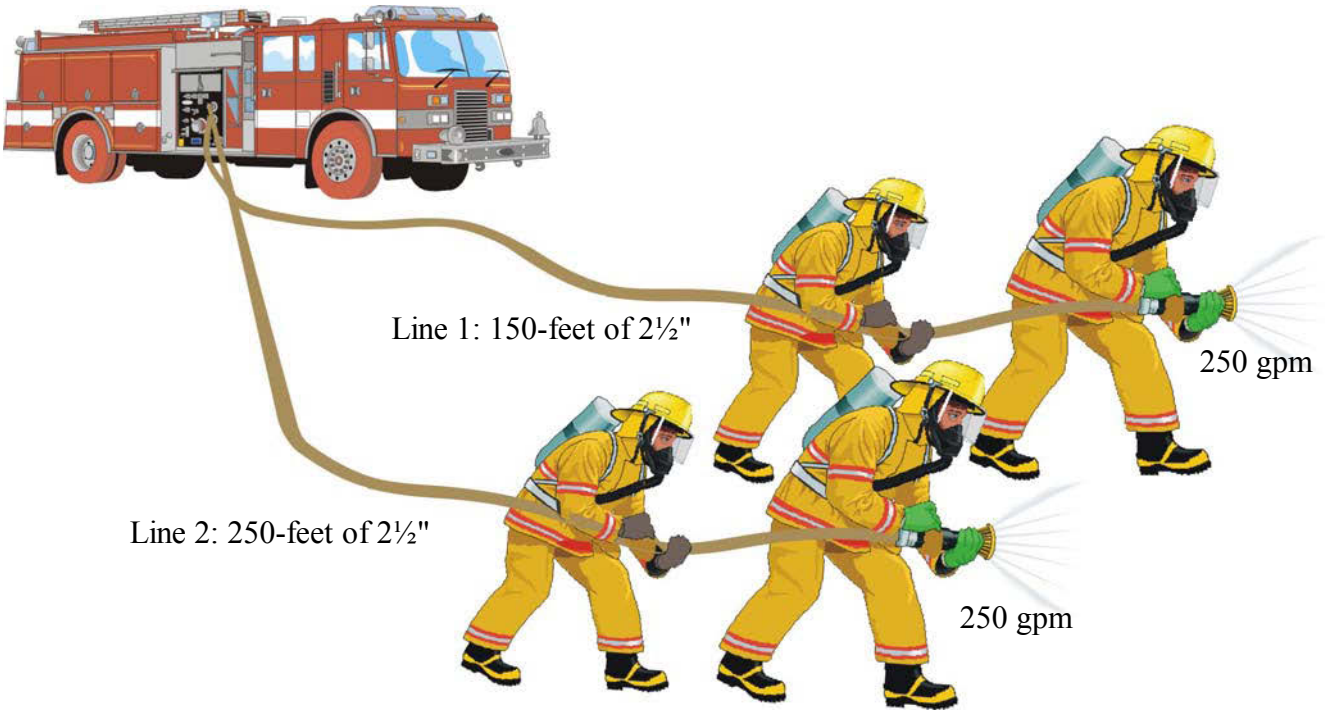


Siamese Lines:		2½" Line:	
FL =	$(C \times Q^2)(L)$	FL =	$(C \times Q^2)(L)$
C =		C =	
Q =		Q =	
L =		L =	
FL =		FL =	
FL =		FL =	

TOTAL FL =

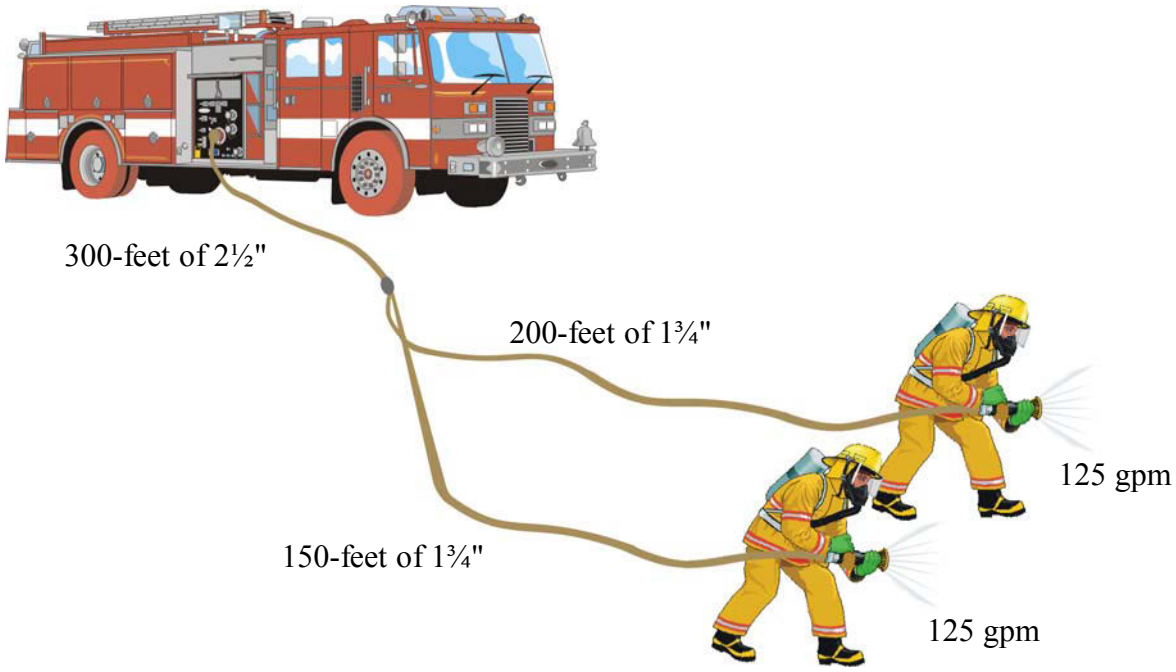
SECTION II: COMPLEX HOSE LAYS

5. Find the correct friction loss.



Line 1:		Line 2:	
FL =	$(C \times Q^2)(L)$	FL =	$(C \times Q^2)(L)$
C =		C =	
Q =		Q =	
L =		L =	
FL =		FL =	
FL =		FL =	

6. Find the correct friction loss.



2½" Line:

FL = $(C \times Q^2)(L)$

C = _____

Q = _____

L = _____

FL = _____

FL = _____

150' Wye Line:

FL = $(C \times Q^2)(L)$

C = _____

Q = _____

L = _____

FL = _____

FL = _____

200' Wye Line:

FL = $(C \times Q^2)(L)$

C = _____

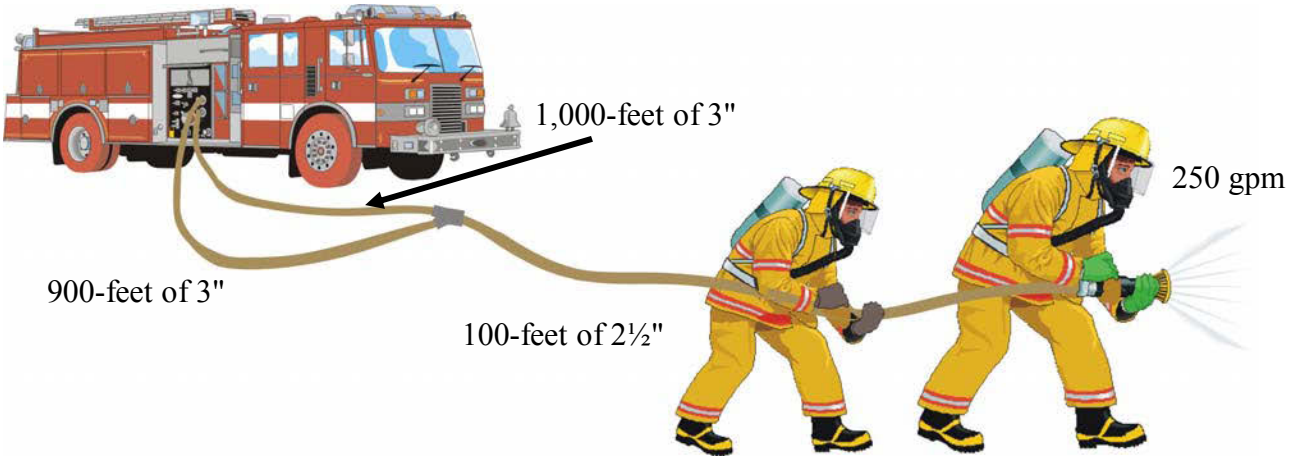
Q = _____

L = _____

FL = _____

FL = _____

7. Find the correct friction loss.



Total length of Line 1 and Line 2 = _____

50% of total length = _____

Siamese Lines:	2½" Line:
FL = $(C \times Q^2)(L)$	FL = $(C \times Q^2)(L)$
C = _____	C = _____
Q = _____	Q = _____
L = _____	L = _____
FL = _____	FL = _____
FL = _____	FL = _____

TOTAL FL = _____

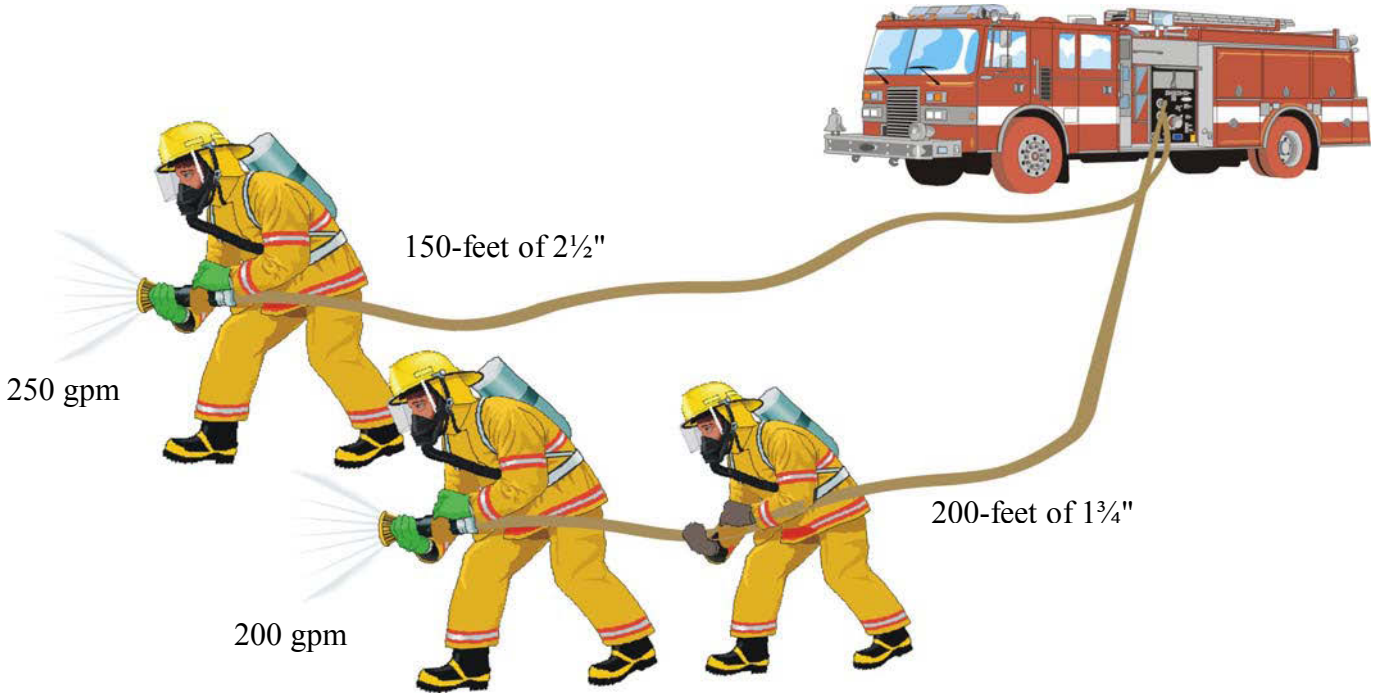
Topic 3-9: Calculating Pump Discharge Pressure

Student information for this topic can also be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 209-213.

INDIVIDUAL ACTIVITY 3-9-1

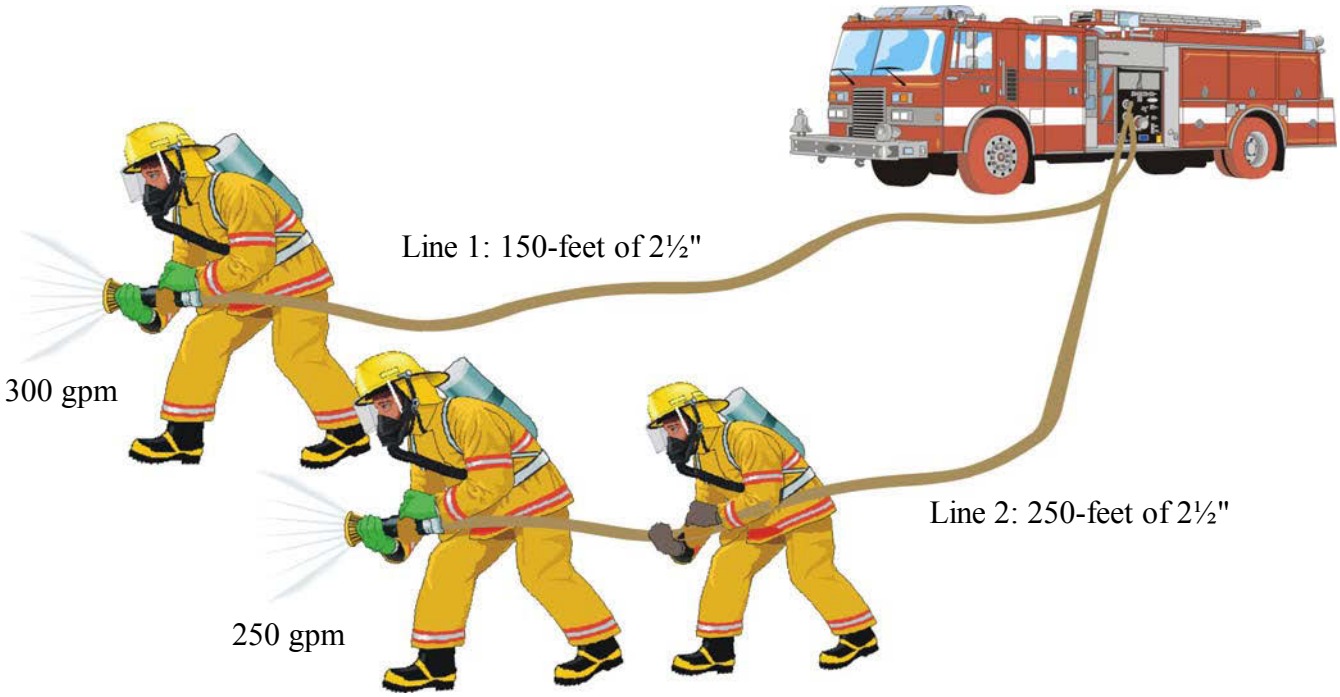
TITLE:	Calculating Pump Discharge Pressure
TIME FRAME:	0:20
MATERIALS NEEDED:	• Calculator • Pen or pencil
INTRODUCTION:	This activity provides you the opportunity to develop your skill to calculate PDP using the proper formula.
DIRECTIONS:	1. Complete all problems using the pump discharge pressure formula. 2. You have 15 minutes to complete this activity. 3. Be prepared to discuss your answers with the class.

1. Calculate the correct pump discharge pressure.



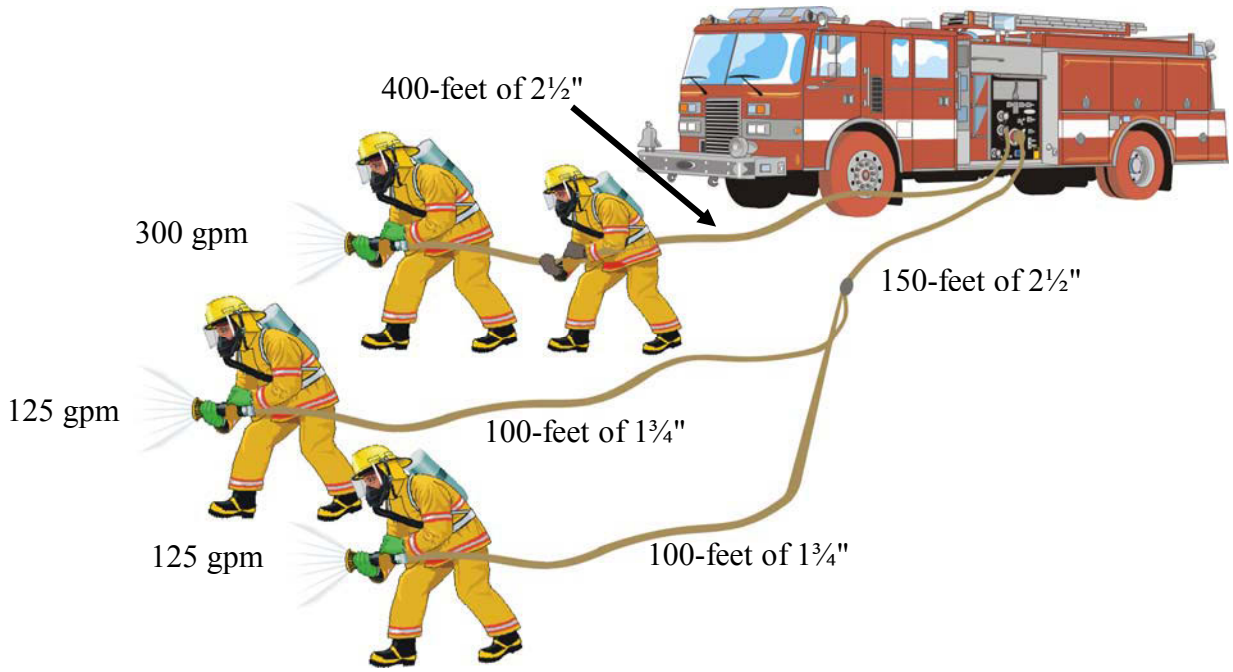
2½" Line:		1¾" Line:	
PDP =	NP + [FL + (AL +/- EP)]	PDP =	NP + [FL + (AL +/- EP)]
NP =		NP =	
FL =		FL =	
AL =		AL =	
EP =		EP =	
PDP =		PDP =	

2. Calculate the correct pump discharge pressure.



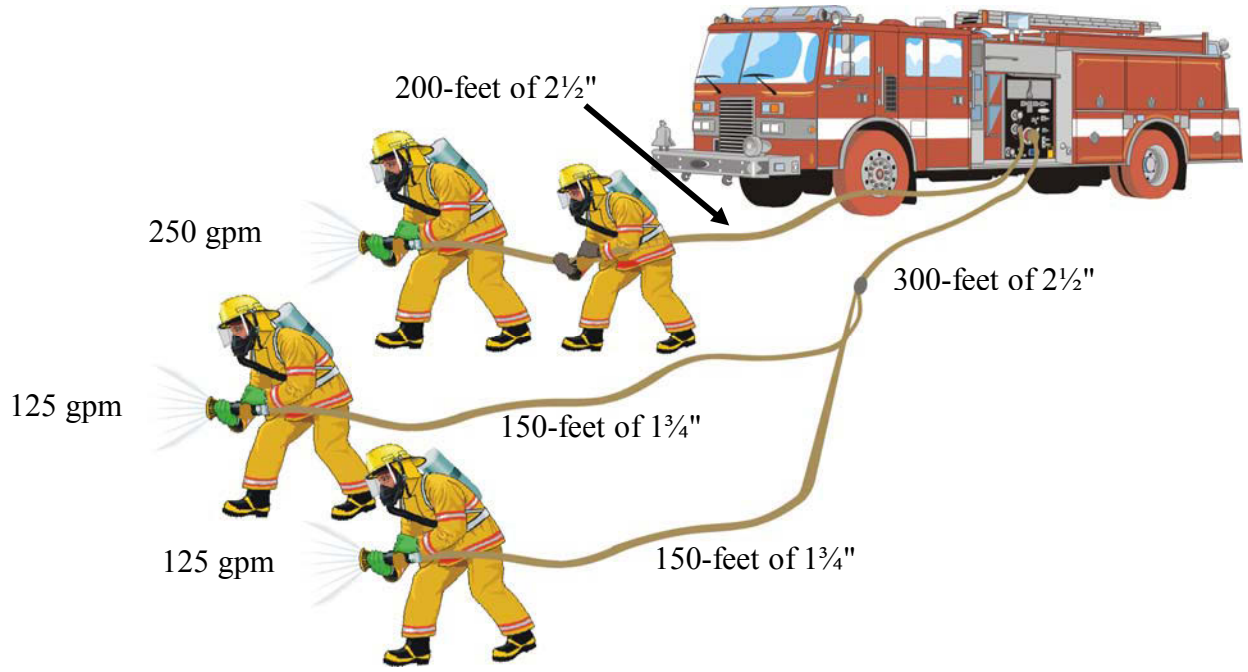
Line 1:		Line 2:	
PDP =	NP + [FL + (AL +/- EP)]	PDP =	NP + [FL + (AL +/- EP)]
NP =		NP =	
FL =		FL =	
AL =		AL =	
EP =		EP =	
PDP =		PDP =	

3. Calculate the correct pump discharge pressure.



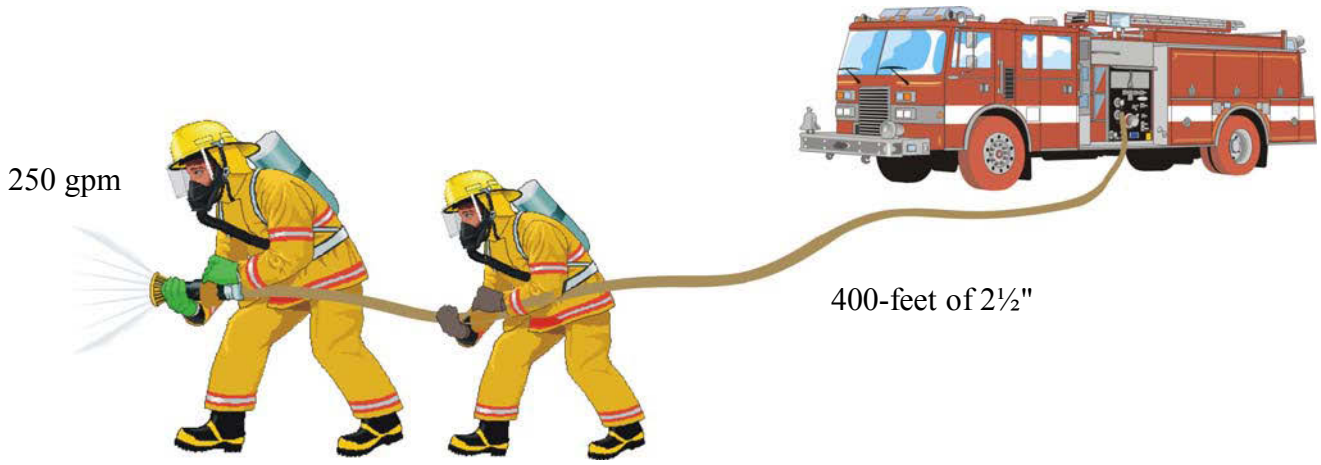
2 ½" Line:		Wye Line:	
PDP =	NP + [FL + (AL +/- EP)]	PDP =	NP + [FL + (AL +/- EP)]
NP =		NP =	
FL =		FL =	
AL =		AL =	
EP =		EP =	
PDP =		PDP =	

4. Calculate the correct pump discharge pressure.



2½" Line:		Wye Line:	
PDP =	NP + [FL + (AL +/- EP)]	PDP =	NP + [FL + (AL +/- EP)]
NP =		NP =	
FL =		FL =	
AL =		AL =	
EP =		EP =	
PDP =		PDP =	

5. Calculate the correct pump discharge pressure.



PDP = NP + [FL + (AL +/- EP)]

NP = _____

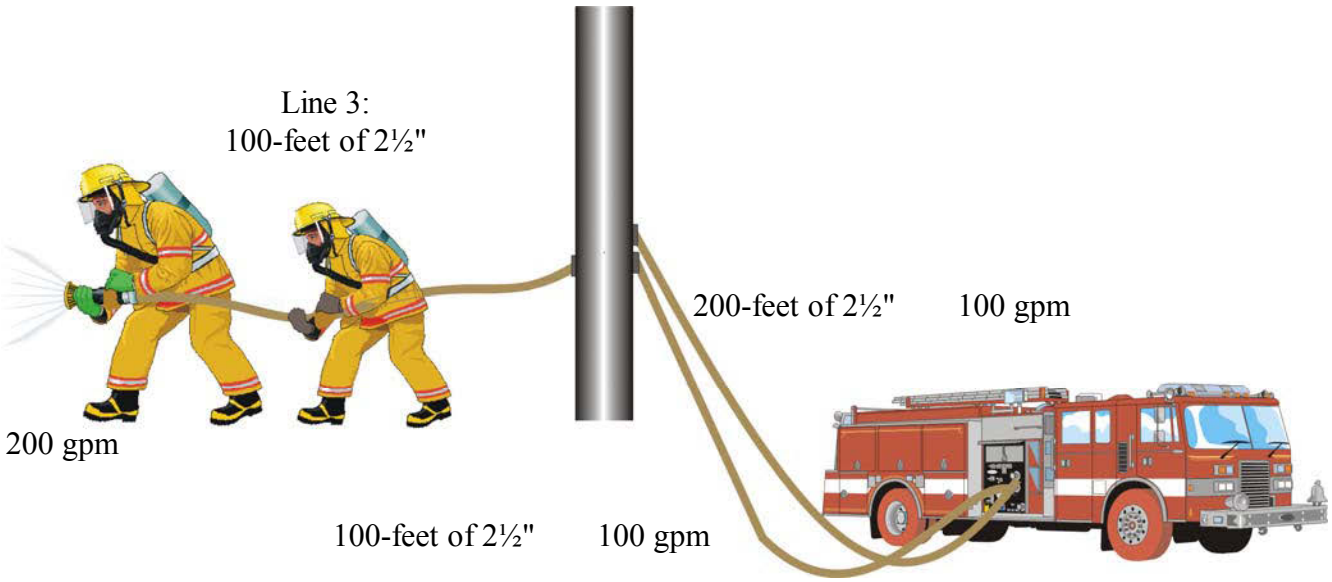
FL = _____

AL = _____

EP = _____

PDP = _____

6. Find the correct pump discharge pressure for the hoselines connected to a standpipe, with fire floor on the third floor, and using 100-feet of 2 ½" hoseline with a fog nozzle at 200 gpm.



PDP = NP + [FL + (AL +/- EP)]

NP = _____

FL = _____

AL = _____

EP = _____

PDP = _____

Topic 3-10: Fireground Hydraulics Calculations

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 251-261.

INDIVIDUAL ACTIVITY 3-10-1

TITLE:	Fireground Hydraulics
TIME FRAME:	0:30
MATERIALS NEEDED:	• Rule of Thumb charts • Calculator • Pen or pencil
INTRODUCTION:	This activity provides you the opportunity to become familiar with and sharpen your skills on fireground hydraulics.
DIRECTIONS:	1. Using the Rule of Thumb charts, calculate the gpm and PDP for the following scenarios. 2. You have 0:15 minutes to complete this activity. 3. Be prepared to discuss your answers with the class.

RULE OF THUMB CHARTS

Nozzle Pressure		
Nozzle	psi	gpm
Smooth Tip (1")	50	200
Fog Nozzles	100	200
Portable Monitor	Same as above	

Fire Hoseline Friction Loss Per 100' Of Hoseline			
3" FL	Tip Size	gpm	2½" FL
2	$^{7}/_{8}$"	150	5
4	1"	200	10
6	$1^{1}/_{8}$"	250	15
8	1¼"	300	20
Q^2	Flow less than 500		

Appliance Friction Loss	
Appliance	psi
Wye	10
Siamese	10
Portable Monitor	25
Standpipe	25

Master Stream Flows (80 psi)	
Tip	gpm
1¼"	400
$1^{3}/_{8}$"	500
1½"	600
$1^{5}/_{8}$"	700
1¾"	800
2"	1,000

Preconnect 1½" and 1¾" ..... PDP = 135 psi

PDP ..... Do Not Exceed 250 psi

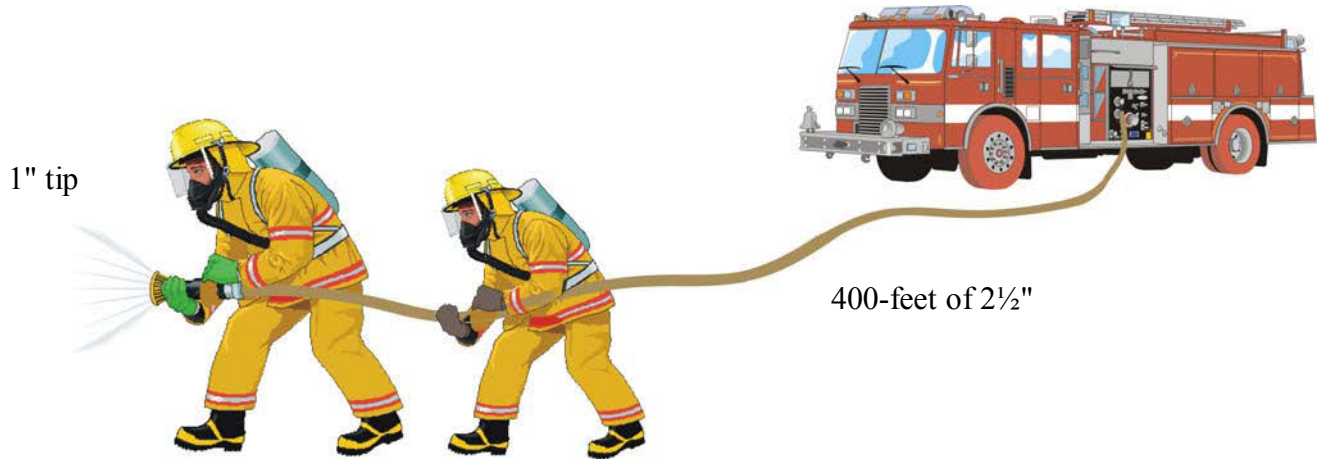
Intake (Residual Pressure) ..... Do Not Drop Below 20 psi

Use Volume Mode ..... 2 or more 2½" or larger hoselines are used pumping 50% or more than the pump capacity

Elevation ..... PDP 5 psi per story minus first story

Supply an Engine ..... 50 psi to start

1. Find the correct gpm and PDP for the hose lay using the information in the Rule of Thumb chart.



gpm = _____

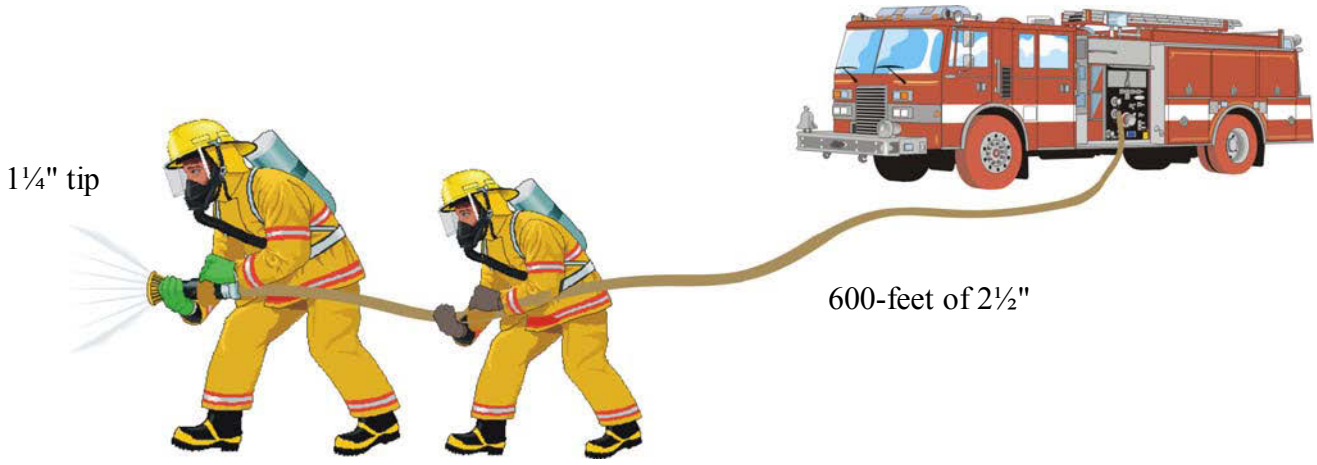
PDP = NP + FL

PDP = _____

PDP = _____

PDP = _____

2. Find the correct gpm and PDP for the hose lay using the information in the Rule of Thumb chart.



gpm = _____

PDP = NP + FL

PDP = _____

PDP = _____

PDP = _____

3. Find the correct gpm and PDP for the hose lay using the information in the Rule of Thumb chart.

gpm = _____

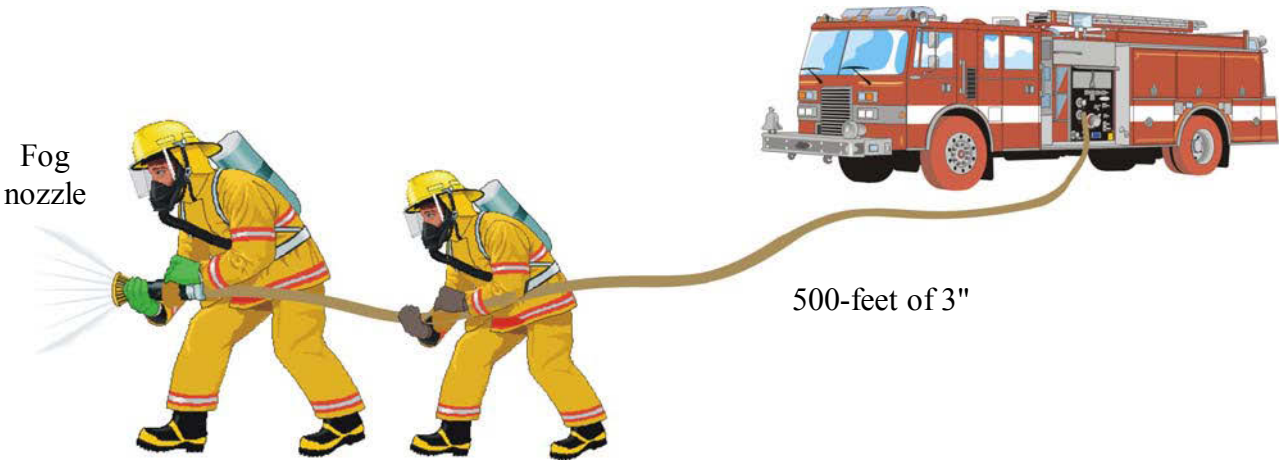
PDP = NP + FL

PDP = _____

PDP = _____

PDP = _____

4. Find the correct gpm and PDP for the hose lay using the information in the Rule of Thumb chart.



gpm = _____

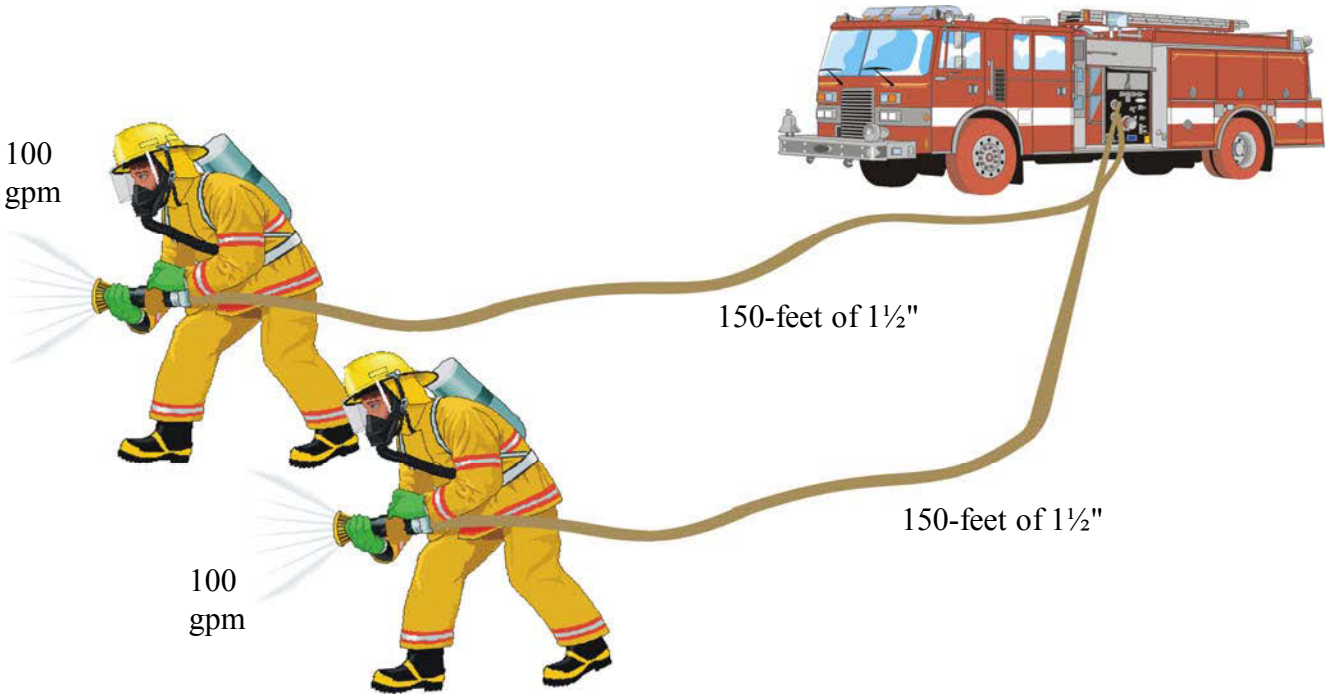
PDP = NP + FL

PDP = _____

PDP = _____

PDP = _____

5. Find the correct PDP for the hose lay using the information in the Rule of Thumb chart.



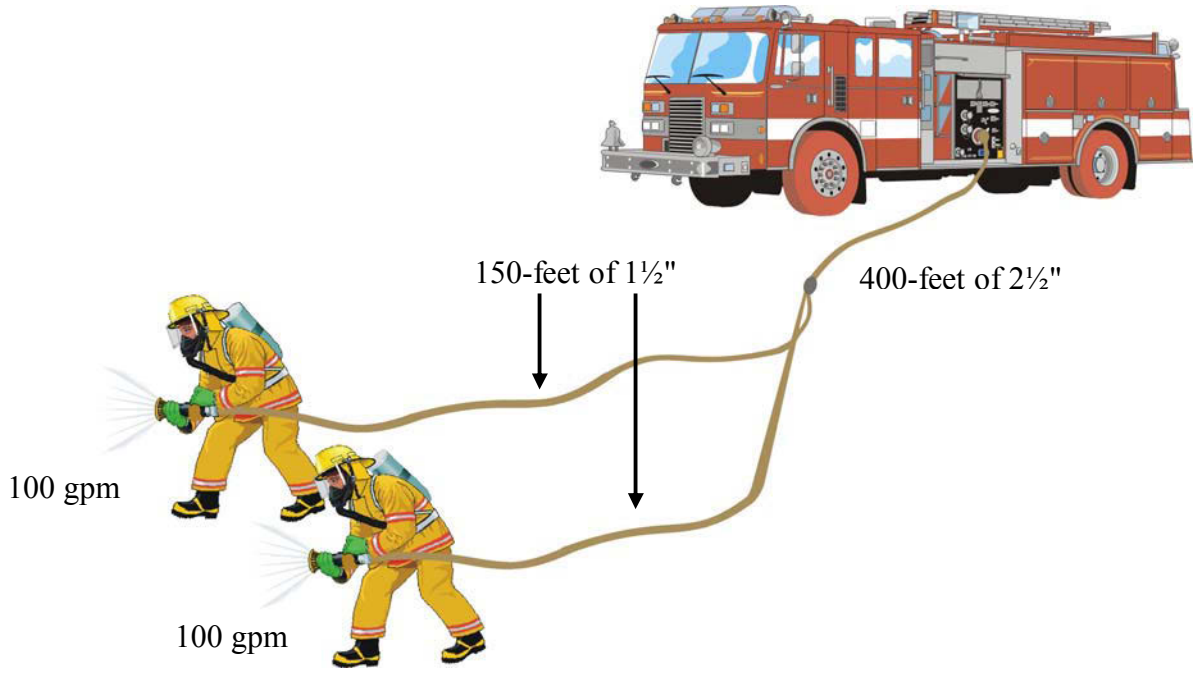
PDP = NP + FL

_____

_____

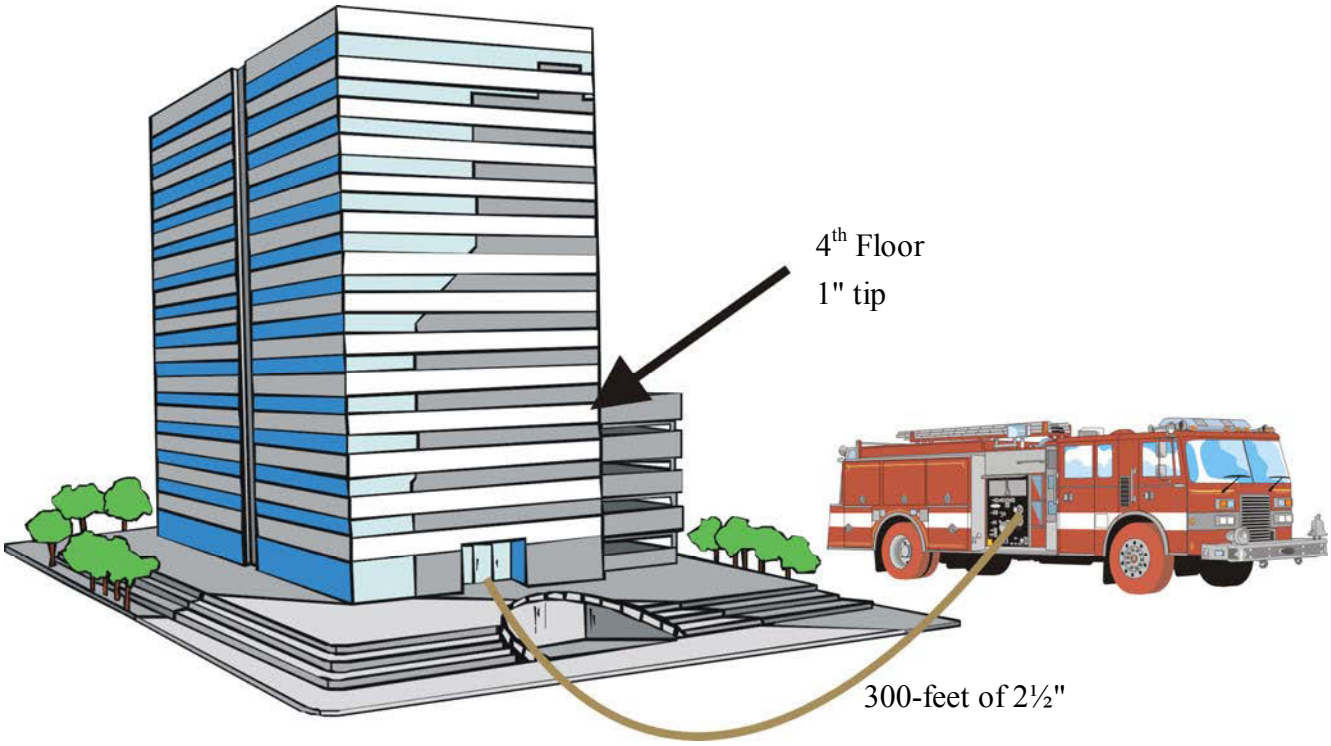
_____

6. Find the PDP for the hose lay using the information in the Rule of Thumb chart.



Wye Line:		2½" Line:	
PDP		gpm =	
		FL =	
		FL =	
		PDP =	

7. Find the correct gpm and PDP for the hose lay up to the fourth floor of a building using the information in the Rule of Thumb chart.



gpm = _____

PDP = NP + FL + EL

PDP = _____

PDP = _____

PDP = _____

Topic 4-1: Inspecting the Pump Drive System

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 51-54 and 280-285.

Topic 4-2: Inspecting the Pump Priming Systems

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 51-54 and 299-301.

Topic 4-3: Inspecting the Pump Pressure Control Systems

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 51-54 and 293-298.

Topic 4-4: Pump Service Testing

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 486-505.

Topic 4-5: Maintenance of the Pump and Control Systems

In order to ensure proper operation of fire apparatus, routine inspection and maintenance must be performed.

After Each Operation

- ❒ Transfer valve.
  - ■ If transfer valve has lubrication fitting, add grease and switch back and forth between positions.
  - ■ With the apparatus engine off, turn the handwheel between the volume and pressure positions a few times to verify that the valve operates freely.
- ❒ Priming pump.
  - ■ Operate primer.
  - ■ Tighten all caps.
  - ■ Close all pump valves.
  - ■ Pull the primer control while watching for a below-zero reading on the master intake gauge.
  - ■ Verify that the master intake gauge readings hold for approximately 5 minutes after you release the primer control.
- ❒ Priming tank.
  - ■ Check lubricant level.
    - Add if necessary.

Weekly

- ❒ Relief valve system or governor.
  - ■ Test at 150, 200, 250 psi.
  - ■ If the apparatus is equipped with an electronic governor, follow the manufacturer's recommendations and specifications for weekly preventive maintenance.
- ❒ Transfer valve (if applicable).
  - ■ Test two-stage pumps only.
  - ■ Manual transfer valves.
    - With the apparatus engine turned off, turn the handwheel between the volume and pressure positions a few times to verify that the valve operates freely.
    - Set up the apparatus for pumping, with the transfer valve in the volume position.
    - Leave the apparatus engine at idle speed and move the transfer valve to the pressure position.
    - Verify that the discharge pressure gauge readings have approximately doubled.
  - ■ Power transfer valves.
    - With the apparatus engine turned off, follow the manufacturer's recommendations and specifications to verify that the valve operates freely.
    - Set up the apparatus for pumping, with the transfer valve in the volume position.

- Note the discharge gauge readings.
- Leave the apparatus engine at idle speed and move the transfer valve to the pressure position.
- Verify that the master intake gauge readings have approximately doubled.

❒ All valves.
- Operational.
  - Discharge, suction, hose, drain, and multi drain.
- Lubricate with dry molly spray.

❒ Remote valve controls.
- Clean and lubricate as necessary.
  - Do not use grease.

❒ Pump shift warning indicator lights.
- Check for operation.
- Move the in-cab pump shift control valve from the ROAD position to the PUMP position.
  - The shift warning lights should come on in a second or two, indicating a complete shift.

❒ Pump gear box.
- Check fluid level and add fluid if needed, following manufacturer's recommendations and specifications.

❒ Pump packing.
- The packing gland is adjusted for a leakage of 8-10 drops per minute at 150 psi (10 bar).
- This slight leakage will lubricate and cool the shaft and packing to prevent burning and scoring of the shaft.
- First, check the leakage rate and adjust the packing gland only if necessary.
- If the leakage rate cannot be adjusted within satisfactory limits, replace the packing per the instructions (every three years).

❒ Suction tube thread.
- Lubricate.
  - Do not use excessive grease.
- Spray all moving parts of the suction, discharge, hose drain, and multi-drain valves with a good grade of lithium base grease.

❒ Intake strainer.
- Clean.
- Check for loss of zinc.

❒ Cap gaskets.
- Inspect and replace if cracked or hard.

❒ Clapper valve.
- Check and exercise, if applicable, in accordance with manufacturer's recommendations and specifications.

Monthly

- ❒ Hydraulic clutch reservoir.
  - Check fluid level.
    - Add if required.
- ❒ Chain drive transmission.
  - Check lubricant level.
    - Add if required.
- ❒ Transfer valve.
  - Shift back and forth between positions.
  - With the apparatus engine off, turn the handwheel between the volume and pressure positions a few times to verify that the valve operates freely.
- ❒ Priming pump.
  - Perform vacuum test.
  - Tighten all caps.
  - Close all pump valves.
  - Pull the primer control while watching for a below-zero reading on the master intake gauge.
- ❒ Pilot valves.
  - Check operation and clean strainer.
- ❒ Intake screens.
  - Check condition.

Annually

- ❒ Anodes.
  - Check condition.
  - Replace when over 75% of the zinc has been consumed.
  - Performance of the anode life will vary with water quality and pH.
- ❒ Gear drive transmission.
  - Change lubricant.
- ❒ Chain drive transmission.
  - Change lubricant.
  - Clean lubricant pump (sump) strainer (if provided)
- ❒ Impeller shaft bearing(s)
  - Add grease.
- ❒ Mechanical seal.
  - Flush seal chamber, if applicable, in accordance with the manufacturer's recommendations and specifications.

- ❒ Service test.
  - Perform service test to NFPA 1911 standards.
- ❒ Pump gear box.
  - Drain and refill.
  - Check the magnetic plug, in accordance with the manufacturer's recommendations and specifications.
- ❒ Drain lines.
  - All drain lines and valves need to be drained and purged with air to ensure that they are functioning properly and are not clogged with sediment or debris.
- ❒ Transfer valves.
  - Lubricate using dry moly spray.
  - With the apparatus engine off, turn the handwheel between the volume and pressure positions a few times to verify that the valve operates freely.
- ❒ Pump packing.
  - It is recommended that pump packing be replaced every 2-3 years.
  - The packing gland is adjusted for a leakage of 8-10 drops per minute at 150 psi (10 bar).
  - This slight leakage will lubricate and cool the shaft and packing to prevent burning and scoring.
  - First, check the leakage rate and adjust the packing gland only if necessary.
  - If the leakage rate cannot be adjusted within satisfactory limits, replace the packing per the instructions (every 2-3 years).

Topic 5-1: Making the Pump Operational

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 51-54, 288-290, and 315-323.

Topic 5-2: Transitioning to an External Water Supply

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 320-323 and 352-356.

Topic 5-3: Operating From a Hydrant

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 107-115, 323-334, and 357-361.

Topic 5-4: Principles and Practices of Drafting Operations

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 334-346.

Topic 5-5: Principles of Relay Pump Operations

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 395-413 and 583.

Topic 5-6: Troubleshooting Pump Operations

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 366-373.

GROUP ACTIVITY 5-6-1

TITLE:	What's Wrong!
TIME FRAME:	1:00
MATERIALS NEEDED:	• Writing board/pad with markers/erasers
INTRODUCTION:	This activity provides you the opportunity to evaluate a problem associated to a pumping operation and identify one or more probable causes and possible corrective actions. You ***cannot*** use the Pumping Apparatus Driver/Operator Handbook to complete this activity.
DIRECTIONS:	1. In your group, develop a probable cause and possible corrective action for each problem based on the symptom provided. 2. Record your responses on the writing board/pad. 3. You have 30 minutes to complete this activity. 4. Be prepared to discuss your answers with the class.

GROUP 1

	OPERATION	PROBLEM	SYMPTOM
1	Common to all	Unable to get a reading on the pressure gauge when the pump is put in service.	Green light indicating that the pump shift transfer is complete is not illuminated.
2	Common to all	Pump will not develop sufficient pressure.	Indicator light shows that the relief valve is closed.
3	Common to all	Pump is unable to supply its rated capacity.	Unable to develop enough engine rpm at full throttle to supply the rated capacity.
4	TANK	While pumping, the discharge pressure drops to a very low value and water supply is interrupted.	Compound gauge on the intake reads "0" or fluctuates; engine speed increases.
5	DRAFT	Pump will not prime.	Electric motor will not operate to drive the primer.
6	DRAFT	Pump loses its prime during the course of a pumping operation.	Pump loses its prime when it is operating near its maximum capacity. Vacuum reading on the intake gauge is near "0" and is fluctuating.

GROUP 2

	OPERATION	PROBLEM	SYMPTOM
1	Common to all	Unable to get a reading on the pressure gauge when the pump is put in service.	Green light is on, no mph reading registers on the speedometer.
2	Common to all	Pump will not develop sufficient pressure.	Engine rpm cannot be raised to the value required as determined by the UL plate, even at full throttle. Tachometer reading is low; pressure gauge reading is too low.
3	Common to all	Pump overheating while in operation.	Pump overheating warning light is on or by physical observation.
4	HYDRANT	Suction line collapses when the discharge valve to a hoseline is opened.	Intake pressure drops to less than "0" and the discharge pressure also drops.
5	DRAFT	Pump will not prime.	Very little air is being discharged from the primer.
6	DRAFT	Pump goes into cavitation when the flow increases.	Intake gauge registers more than 22 inches of vacuum; the pressure gauge fluctuates and decreases reading.

GROUP 3

	OPERATION	PROBLEM	SYMPTOM
1	Common to all	Unable to get a reading on the pressure gauge when the pump is put in service.	Speedometer reading is normal for pump operation. All indications are correct and rpm reading is as specified.
2	Common to all	Pump is unable to supply its rated capacity.	The rpm reading on the tachometer is normal when compared to the UL plate.
3	Common to all	Relief valve is inoperative or slow acting.	Pressure surges are excessive when individual hoselines are shutdown.
4	HYDRANT	Suction line collapses when the discharge valve to a hoseline is opened.	Water coming out of the ground around the barrel of the hydrant.
5	DRAFT	Pump loses its prime when the first discharge valve is opened and water begins to flow.	Discharge pressure gauge drops sharply.
6	RELAY	Intake supply line collapses when the throttle setting is increased to establish the initial discharge pressure as required.	Intake pressure gauge reading is negative (reading vacuum instead of pressure).

GROUP 4

	OPERATION	PROBLEM	SYMPTOM
1	Common to all	Pump will not develop sufficient pressure.	The rpm reading on the tachometer is normal when compared with the UL plate.
2	Common to all	Pump is unable to supply its rated capacity.	Intake gauge registers "0" or has a positive pressure indicated.
3	TANK	Unable to establish an adequate operating pressure or a loss of pressure occurs when the first discharge valve is opened.	Pressure increases with the engine rpm up to a point, then holds steady or fluctuates.
4	HYDRANT	While supplying water, the suction line collapses and the pump begins to cavitate.	Intake pressure drops to less than "0" and discharge pressure fluctuates and decreases.
5	DRAFT	Pump loses its prime when the first discharge valve is opened and water begins to flow.	Reading on the pressure gauge drops sharply and the intake gauge returns to the "0" reading.
6	RELAY	While the relay is operating, the intake pressure increases above 50 psi.	Intake pressure gauge is reading above 50 psi and the discharge pressure also increases accordingly.

GROUP 5

	OPERATION	PROBLEM	SYMPTOM
1	Common to all	Pump will not develop sufficient pressure.	Relief valve is operating and the indicator light is on.
2	Common to all	Pump is unable to supply its rated capacity.	Intake compound gauge is registering a high vacuum and the discharge pressure gauge is fluctuating (cavitation).
3	TANK	Fluctuation of the pressure gauge and a reduction of discharge pressure when additional lines are put in service.	High vacuum reading on the intake compound gauge.
4	DRAFT	Pump will not prime.	Unable to get water into the pump through the hard suction hose. No vacuum reading is registered on the intake compound gauge.
5	DRAFT	Pump loses its prime during the course of a pumping operation.	Pump loses its prime when all nozzles are closed and no water is flowing.
6	RELAY	While the relay is operating, the intake pressure increases dangerously.	Intake pressure gauge is reading above 150 psi, the discharge pressure is above 200 psi.

Topic 5-7: Principles of Tandem Pumping Operations

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 115 and 584-585.

Topic 5-8: Principles of Dual Pumping Operations

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 113-115 and 575.

Topic 5-9: Principles and Practices of Foam Operations

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 451-480.

Topic 5-10: Sprinkler and Standpipe Support

Student information for this topic can be found in Pumping Apparatus Driver/Operator Handbook, IFSTA, Second Edition, Pages 347-348.

Topic 6-1: Mandatory Pumping Exercises

PUMPING EXERCISE 6-1-1

EXERCISE:	Operating From Draft This exercise allows the driver/operator to become familiar with using a static water source as a supply while operating the pump controls safely and maintaining an effective fire stream. Fire hydrants are not always available at the scene, and the driver/operator may have to use some imagination to determine an alternate water supply. Solving a hydraulics problem is required.
TIME FRAME:	10:00 (per student)
AUTHORITY:	2009 NFPA 1002: Section 5.2
MATERIALS NEEDED:	• Fire apparatus • 2,400 square foot area (30' x 80') • Drafting source • Stopwatch • 1½" or 1¾" hoseline • Hard suction hose • Student assistant
STUDENT DIRECTIONS:	1. Make the proper hose connections. 2. Develop and maintain draft. 3. Establish and maintain a fire stream. 4. Solve the hydraulics problem(s). 5. Set the relief valve. 6. Safely shutdown all lines and disengage the pump. 7. Continually interpret gauge readings throughout the exercise and recall those readings to the instructor. 8. Step-by-step procedures are listed on the Scoring Sheet.

SCORING:

120 points possible **80% passing**

1. **Points** are deducted for each step not completed.
2. The student fails if a step marked with an asterisk (*) is omitted.
3. The student **fails** if the exercise is not completed within the allotted time.
4. The student **fails** if any personal injury occurs.
5. The student **fails** if he or she does not engage the pump.
6. The student **fails** there is apparatus abuse.

SITE PREPARATION:

- Apparatus is properly parked and chocked next to the drafting source.
- Parking brake is set.
- Main engine is shutoff.
- Tank-to-pump valve is open.
- Tank fill valve is closed.
- Water tank and pump in the apparatus are empty.
- Hoseline is laid out on the ground with the female end near the apparatus. This line can be directed back into the drafting source.
- Hard suction hose is placed near apparatus, but is not attached.
- If using a multi-stage pump, the transfer valve will be set to the volume setting.

PUMPING EXERCISE 6-1-1 SCORING SHEET

STUDENT: _____ DATE: _____

6-1-1: OPERATING FROM DRAFT		Penalty points subtracted from 100 possible points.	
	Rated Component	**Value**	**120**
1.	Start engine prior to leaving cab	5	
	TIME STARTS (When student's foot touches the ground)		
2.	Connect hard suction hose to apparatus and place in drafting source	5	
3.	Connect hoseline to designated discharge	5	
4.	Close all valves and drains	5	
5.	Engage midship pump	*	
6.	Throttle engine up to 1000 – 1200 rpm	5	
7.	Engage primer for no more than 30 – 45 seconds or until water has filled hard suction hose	5	
8.	Operate pump panel throttle slowly until the PDP reads 100 psi (If prime is lost, repeat step 6)	10	
9.	Loudly state, "Water coming"	10	
10.	Slowly open designated discharge valve	5	
11.	Calculate field hydraulics for the hoseline and nozzle being used	10	
12.	Readjust the pump panel throttle slowing until the proper PDP is reached (± 5 psi)	10	
13.	Properly adjust the pressure relief valve	10	
	TIME STOPS		
14.	The student must recall and interpret the gauge readings	5	
	SHUTDOWN PROCEDURES		
1.	Loudly state, "Shutdown"	5	
2.	Slowly close discharge valve	2	
3.	Slowly reduce pump panel throttle until main engine returns to idle	2	
4.	Return to cab and disengage pump	2	
5.	Shut-off main engine	2	
6.	Open tank-to-pump valve and drain pump	2	
7.	Disconnect hoseline and hard suction hose	2	
	MISCELLANEOUS		
1.	Dropped a brass coupling	2	
2.	Opened valves too fast	2	
3.	Left compartment door open	2	

STUDENT: _____ DATE: _____

6-1-1: OPERATING FROM DRAFT		Penalty points subtracted from 100 possible points.	
	Rated Component	**Value**	**120**
4.	Failed to remove kinks in hose(s)	2	
5.	Failed to disengaging the pump	5	
	ITEMS THAT WILL RESULT IN AUTOMATIC FAILURE		
1.	Omitted a step marked with an asterisk (*)	☐ Yes	Failure
2.	Exceeded the allotted time	☐ Yes	Failure
3.	Acted in a manner resulting in any personal injury	☐ Yes	Failure
4.	Failed to engage the pump	☐ Yes	Failure
5.	Abused the apparatus	☐ Yes	Failure

ALLOTTED TIME: **10:00 MINUTES** **TOTAL POINTS:** _____

COMPLETION TIME: _____ **PASSING SCORE:** 96

Scorer's Name: _____

PASS/FAIL: ☐ Pass ☐ Fail ☐ Retest

Signature: _____

6-1-1 NOTES:

PUMPING EXERCISE 6-1-2

EXERCISE:	Operating Using A Forward Lay This exercise will allow the driver/operator to become proficient at using tank water with the first attack line; then changing over to a pressurized water source and flowing a second attack line. Solving a hydraulics problem is required.
TIME FRAME:	10:00 (per student)
AUTHORITY:	2009 NFPA 1002: Section 5.2
MATERIALS NEEDED:	• Fire apparatus • 10,000 square foot area (50' x 200') • Hydrant • Stopwatch • 100-foot supply hose (minimum) • 150-foot length of 1½" or 1¾" discharge hoseline • 150-foot length of 2½" discharge hoseline • Student assistant
STUDENT DIRECTIONS:	1. Break supply line form hose bed and connect to inlet suction. 2. Solve the hydraulic problem for the first hoseline, then charge. 3. Set the relief valve. 4. Perform changeover from tank to hydrant. 5. Solve hydraulic problem for the second hoseline, then charge. 6. Safely shutdown all lines and disengage the pump. 7. Continually interpret gauge readings throughout the exercise and recall those readings to the instructor. 8. Step-by-step procedures are listed on the Scoring Sheet.

SCORING:	**150 points possible**	**80% passing**

1. **Points** are deducted for each step not completed.
2. The student fails if a step marked with an asterisk (*) is omitted.
3. The student **fails** if the exercise is not completed within the allotted time.
4. The student **fails** if any personal injury occurs.
5. The student **fails** if he or she does not engage the pump.
6. The student **fails** if the pump is run dry.
7. The student **fails** there is apparatus abuse.

SITE PREPARATION:

- Apparatus is parked at a simulated fire incident.
- Tank-to-pump valve is open.
- Tank fill valve is closed.
- Supply line laid out on the ground and connected to hydrant discharge and hose bed.
- Two (2) hoselines of different sizes are laid out on the ground and connected to the apparatus.

PUMPING EXERCISE 6-1-2 SCORING SHEET

STUDENT: _____ DATE: _____

6-1-2: OPERATING USING A FORWARD LAY		Penalty points subtracted from 150 possible points.	
	Rated Component	**Value**	**150**
1.	Start engine and engage midship pump	5	
	TIME STARTS (When student's foot touches the ground)		
2.	Set chock blocks according to local policy	*	
3.	Break supply line apart from hose bed and attach to suction inlet	5	
4.	Call for assistant at hydrant to charge supply line	*	
5.	Loudly state "Water coming"	10	
6.	Slowly open discharge valve for the 1½" (1¾") hoseline	5	
7.	Calculate field hydraulics for the 1½" (1¾") hoseline using field hydraulic formulas	10	
8.	Operate pump panel throttle slowly until proper PDP pressure is reached (± 5 psi)	5	
9.	Properly adjust the pressure relief valve	10	
10.	Open suction inlet valve while simultaneously reducing throttle to maintain proper PDP	*	
11.	PDP should return to Step 7's calculations	10	
12.	Calculate field hydraulics for the 2 ½" hoseline using field hydraulic formulas	10	
13.	Loudly state, "Water Coming"	10	
14.	Slowly open discharge valve for 2½" hoseline until proper PDP is achieved (± 5 psi)	5	
15.	Tank-to-pump valve (Leave open or close according to local policy)	4	
16.	Open tank filler valve slightly to refill tank while keeping PDP consistent	10	
	TIME STOPS		
17.	Close tank filler valve when tank is full	5	
18.	The student must recall and interpret the gauge readings	10	
	SHUTDOWN PROCEDURES		
1.	Loudly state, "Shutdown"	5	
2.	Slowly reduce pump panel throttle until main engine returns to idle	2	
3.	Slowly close discharge valve and suction valve	2	
4.	Return to cab and disengage pump	2	
5.	Have assistant shut-off hydrant	2	
6.	Relieve pressure form suction hose	2	
7.	Close suction valve and disconnect suction hose from suction inlet	2	

STUDENT: _____ DATE: _____

6-1-2: OPERATING USING A FORWARD LAY		Penalty points subtracted from 150 possible points.	
	Rated Component	**Value**	**150**
8.	Open tank-to-pump valve (If closed in step 14 above)	2	
9.	Reset pressure relief valve	2	
10.	Pick up chocks and return to proper location	2	
	MISCELLANEOUS		
1.	Dropped brass couplings	2	
2.	Opened valves too fast	2	
3.	Left compartment door open	2	
4.	Failed to remove kinks in hose(s)	2	
5.	Failed to disengage the pump	5	
	ITEMS THAT RESULT IN AUTOMATIC FAILURE		
1.	Omitted a step marked with an asterisk (*)	☐ Yes	Failure
2.	Exceeded the allotted time	☐ Yes	Failure
3.	Acted in a manner resulting in any personal injury	☐ Yes	Failure
4.	Failed to engage the pump	☐ Yes	Failure
5.	Ran the pump dry (without water)	☐ Yes	Failure
6.	Abused the apparatus	☐ Yes	Failure

ALLOTTED TIME: **10:00 MINUTES** **TOTAL POINTS:** _____

COMPLETION TIME: _____ **PASSING SCORE:** 120

Scorer's Name: _____

PASS/FAIL: ☐ Pass ☐ Fail ☐ Retest

Signature: _____

6-1-2 NOTES:

PUMPING EXERCISE 6-1-3

EXERCISE:	Operating Using A Reverse Lay This exercise can be applied when the driver/operator needs to place an appliance at the incident and then drive to the water source. Solving a hydraulics problem is required.
TIME FRAME:	5:00 (per student)
AUTHORITY:	2009 NFPA 1002: Section 5.2
MATERIALS NEEDED:	• Fire apparatus • 1,000 square foot area (50' x 200') • Hydrant • Stopwatch • Monitor with 500 gpm nozzle minimum • Hose to supply monitor (Instructor choice) • 15-20 foot length of soft suction hose • Student assistant
STUDENT DIRECTIONS:	1. Drive the apparatus to the hydrant and spot. 2. Connect hoselines from the monitor to the apparatus. 3. Connect supply hose to the hydrant. 4. Solve the hydraulics problem, and then charge the hoselines. 5. Set the relief valve. 6. Safely shutdown all lines and disengage pump. 7. Continually interpret gauge readings throughout the exercise and recall those readings to the instructor. 8. Step-by-step procedures are listed on the Scoring Sheet.

SCORING:	**150 points possible** **80% passing**
SCORING:	1. **Points** are deducted for each step not completed. 2. The student fails if a step marked with an asterisk (*) is omitted. 3. The student **fails** if the exercise is not completed within the allotted time. 4. The student **fails** if any personal injury occurs. 5. The student **fails** if he or she does not engage the pump. 6. The student **fails** if the pump is run dry. 7. The student **fails** there is apparatus abuse.
SITE PREPARATION:	• Monitor is set-up at a simulated fire incident. • Tank-to-pump valve is open. • Tank fill valve is closed. • Hoseline(s) are laid out on the ground, connected to the monitor, and laid back to the hydrant

PUMPING EXERCISE 6-1-3 SCORING SHEET

STUDENT: _____ DATE: _____

6-1-3: OPERATING USING A REVERSE LAY		Penalty points subtracted from 150 possible points.	
	Rated Component	**Value**	**150**
1.	Start engine and drive apparatus to hydrant	5	
2.	Spot apparatus correctly at hydrant	5	
3.	Set parking brake and engage pump	*	
	TIME STARTS (When student's foot touches the ground)		
4.	Set chock blocks according to local policy	*	
5.	Connect hoseline(s) from monitor to appropriate apparatus discharge(s)	5	
6.	Rollout suction hose to hydrant	5	
7.	Connect suction hose to suction inlet	5	
8.	Flush hydrant (Engine should not be in path of water flow)	10	
9.	Connect suction hose to hydrant	5	
10.	Open hydrant (Remove kinks from supply line)	10	
11.	Open inlet suction valve	5	
12.	Tank-to-pump valve (Leave open or close according to local policy)	5	
13.	Loudly state, "Water Coming"	10	
14.	Slowly open discharge valve(s)	5	
15.	Calculate field hydraulics for the appliance using field hydraulic formulas	10	
16.	Operate pump panel throttle slowly until proper PDP is reached (± 5 psi)	5	
17.	Properly adjust the pressure relief valve	10	
	TIME STOPS		
18.	The student must recall and interpret the gauge readings	10	
	SHUTDOWN PROCEDURES		
1.	Loudly state, "Shutdown"	5	
2.	Slowly reduce pump panel throttle until main engine returns to idle	2	
3.	Slowly close discharge valve(s)	2	
4.	Return to cab and disengage pump	2	
5.	Shutoff hydrant	2	
6.	Close suction inlet valve	2	
7.	Relieve pressure from suction hose	2	
8.	Disconnect suction hose from suction inlet and hydrant	2	
9.	Replace suction hose on apparatus	2	

STUDENT: _____ DATE: _____

6-1-3: OPERATING USING A REVERSE LAY		Penalty points subtracted from 150 possible points.	
	Rated Component	**Value**	**150**
10.	Disconnect hoseline(s) to monitor and lay on ground at hydrant	2	
11.	Open tank-to-pump valve (If closed in step 12 above)	2	
12.	Pick up chocks and return to proper location	2	
	MISCELLANEOUS		
1.	Dropped brass couplings	2	
2.	Opened valves too fast	2	
3.	Left compartment door open	2	
4.	Failed to remove kinks in hose(s)	2	
5.	Failed to disengage the pump	5	
	ITEMS THAT RESULT IN AUTOMATIC FAILURE		
1.	Omitted a step marked with an asterisk (*)	☐ Yes	Failure
2.	Exceeded the allotted time	☐ Yes	Failure
3.	Acted in a manner resulting in any personal injury	☐ Yes	Failure
4.	Failed to engage the pump	☐ Yes	Failure
5.	Ran the pump dry (without water)	☐ Yes	Failure
6.	Abused the apparatus	☐ Yes	Failure

ALLOTTED TIME: **5:00 MINUTES** **TOTAL POINTS:** _____

COMPLETION TIME: _____ **PASSING SCORE:** 120

Scorer's Name: _____

PASS/FAIL: ☐ Pass ☐ Fail ☐ Retest

Signature: _____

6-1-3 NOTES: