HYDRAULICS

TABLE OF CONTENTS

DEFINITION OF HYDRAULICS .................................................................................................................. 2
WATER HAMMER ......................................................................................................................................... 2
FRICITION LOSS PER 100 FEET OF HOSE ................................................................................................. 2
FORMULAS .................................................................................................................................................. 3
FACTS .......................................................................................................................................................... 3
FRICITION LOSS COEFFICIENT TABLE (C) ................................................................................................. 3
ELECTRIC PRIMING METHOD .................................................................................................................... 3
MANUALLY PRIMING PUMP ....................................................................................................................... 4
SETTING THE RELIEF VALVE .................................................................................................................... 4
CALCULATING ADDITIONAL WATER AVAILABLE FROM A HYDRANT .................................................. 4
NATIONAL FIRE ACADEMY FIRE FLOW FORMULA ................................................................................... 5
PUMP PRESSURE FOR APPLIANCES (RULE OF THUMB) ........................................................................ 5
GPM FLOW FROM SOLID BORE NOZZLES – RULE OF THUMB ............................................................. 5
HOSE LOADS (LOADING 4” & 5” IN THE HOSEBED) ............................................................................... 5
FORWARD LAY 3” HOSE (FORWARD LAYOUT WITH 3” FEEDER LINE) .................................................. 6
FORWARD LAY 4” HOSE (FORWARD LAYOUT WITH 4” FEEDER LINE) .................................................. 6
HOSE CLAMPS ........................................................................................................................................... 6
4” HOSE INTAKE CONNECTION ............................................................................................................... 6
HYDRASSIST OPERATION ......................................................................................................................... 7
REVERSE LAY ............................................................................................................................................ 7
FULL STRIP / PARTIAL STRIP ...................................................................................................................... 8
PUMPING TO A SPRINKLER/STANDPIPE CONNECTION .................................................................... 8
RELAY PUMPING 4” HOSE (1,000 GPM) ............................................................................................... 8
PRECONNECTS ............................................................................................................................................ 9
TRIPLE LAYER LOAD ................................................................................................................................. 9
MINUTEMAN LOAD (REAR HOSE BED ONLY) ....................................................................................... 9
ACCORDION LOAD .................................................................................................................................. 9
PULLING A TRIPLE LAYER LOAD ........................................................................................................... 9
PULLING A MINUTEMAN LOAD ................................................................................................................ 9
PULLING A QUICK DEPLOYMENT LOAD ................................................................................................. 10
PORTABLE SPRINKLER SYSTEM ........................................................................................................... 10
BUNDLING PORTABLE SPRINKLERS ......................................................................................................... 10
**DEFINITION OF HYDRAULICS**

The science of fire hydraulics is a branch of general hydraulics, which deals with the mechanical principles of water in motion. Areas covered in fire hydraulics are water flow, pressure losses, nozzle pressure, reactions and pump discharge pressures. Firefighters need to be familiar with and have a working knowledge of fire hydraulics. On the fireground, the firefighter must be able to compute these various areas covered in fire hydraulics by using rule of thumb. This manual will deal with rule of thumb. On Page 7, a fact and formula sheet is in place for quick reference. Any references to actual formulas for hydraulics should be made to the IFSTA Pumping Apparatus Driver/Operator 1st Edition Red Book.

**WATER HAMMER**

Water hammer plays a very important part in the use of Large Diameter Hose (LDH). It is also present in smaller hose lines. Water hammer is magnified in LDH. Suddenly stopping water moving through a hose or pipe results in an energy surge being transmitted in the opposite direction, often at many times the original pressure. This surge is referred to as water hammer. Water hammer can damage the pump, appliances, hose, or the municipal water system itself. Always open and close nozzle controls, hydrants, valves, and hose clamps slowly to prevent water hammer. Valves on the pump, nozzles, and appliances MUST be opened and closed slowly.

**NOTE:** The 10 Second Rule should be used to open and close valves when flowing water. The 10 Second Rule means the firefighter should count 10 seconds when opening or closing a valve.

Remember, you are laying a portable water main above ground and catastrophic damage can be done to pumps, appliances, hose, and the city water system. Pumps can be cracked or broken, appliances damaged, hose burst, and water mains broken underground. Any of these things caused by water hammer can cause injury to firefighting personnel.

<table>
<thead>
<tr>
<th>HOSE SIZE</th>
<th>CONSTRUCTION</th>
<th>COUPLING TYPE</th>
<th>ANNUAL TEST PRESSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5&quot;</td>
<td>Synthetic, Rubber Lined</td>
<td>Storz</td>
<td>200</td>
</tr>
<tr>
<td>4&quot;</td>
<td>Synthetic, Rubber Lined</td>
<td>Storz</td>
<td>200</td>
</tr>
<tr>
<td>3&quot; w/ 2 ½&quot; Couplings</td>
<td>Polyester Double-Jacket, Rubber Lined</td>
<td>Extruded Aluminum</td>
<td>300</td>
</tr>
<tr>
<td>2 ½&quot;</td>
<td>Polyester Double-Jacket, Rubber Lined</td>
<td>Extruded Aluminum</td>
<td>300</td>
</tr>
<tr>
<td>2&quot; w/ 1 ½&quot; Couplings</td>
<td>Polyester Double-Jacket, Rubber Lined</td>
<td>Extruded Aluminum</td>
<td>300</td>
</tr>
<tr>
<td>1 ¼&quot; w/ 1 ½&quot; Couplings</td>
<td>Polyester Double-Jacket, Rubber Lined</td>
<td>Extruded Aluminum</td>
<td>300</td>
</tr>
<tr>
<td>1&quot; &amp; ¼&quot; w/ 1&quot; Couplings (Booster Hose)</td>
<td>Reinforced, Rubber-Covered, Rubber Lined</td>
<td>Brass</td>
<td>300</td>
</tr>
</tbody>
</table>

**MAX LENGTH FOR TEST (All Sizes): 300 Feet**

**FRICTION LOSS PER 100 FEET OF HOSE**

<table>
<thead>
<tr>
<th>HOSE SIZE</th>
<th>GPM&gt;&gt;&gt;</th>
<th>Lines</th>
<th>100</th>
<th>125</th>
<th>150</th>
<th>175</th>
<th>200</th>
<th>250</th>
<th>350</th>
<th>500</th>
<th>1000</th>
<th>1500</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 3/4&quot;</td>
<td>1</td>
<td>15</td>
<td>25</td>
<td>35</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>2&quot;</td>
<td>1</td>
<td>18</td>
<td>20</td>
<td>20</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>2 1/2&quot;</td>
<td>1</td>
<td>13</td>
<td>15</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>3&quot; w/ 2 1/2&quot; connections</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>4&quot;</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>5&quot;</td>
<td>1</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

| Actual Friction Loss | Rule of Thumb | Actual/Rule of Thumb (same) |
FORMULAS

Friction Loss (with coefficient)
\[ FL = CQ^2L \]
- \( FL \) = Friction Loss
- \( C \) = Coefficient
- \( Q \) = Flow rate in hundreds of GPM (GPM/100)
- \( L \) = Hose length in hundreds of feet (L/100)

Area of a Circle
\[ A = \pi R^2 \text{ OR } A = D^2 \times 0.7854 \]
- \( A \) = Area of circle in square inches
- \( \pi \) = 3.14
- \( D \) = Diameter
- 0.7854 = a constant

Volume or Capacity of a Round Tank (Rule of Thumb)
\[ V = D^2 \times 6 \times L \]
- \( D \) = Diameter
- 6 = a constant
- \( L \) = Length

Nozzle Reaction or Kickback (solid stream tip)
\[ NR = 1.5 \times D^2 \times NP \]
- \( NR \) = Nozzle Reaction
- 1.5 = a constant
- \( D \) = Nozzle Diameter in inches
- \( NP \) = Nozzle Pressure in psi

Fog Nozzle Kickback (Rule of Thumb)
\[ 1/2 \text{ the GPM flow} \]

FACTS
- 1 psi will lift water 2.304 feet.
- Base pressure for 1 foot of rise is 0.434 psi.
- 1 cubic foot of water weighs 62.5 lbs.
- 1 gallon of water weighs 8.33 lbs.
- 1 cubic foot of water is 7.5 gallons.
- Condensed Q formula is \( Q^2 \).
- Raise or lower pump discharge pressure for supply lines in increments of 25 psi.
- Raise or lower pump discharge pressure for attack lines in increments of 10 psi.
- At 212°F, a cubic foot of water expands approximately 1,700 times its original volume. At higher temperatures, water will expand even more times than its original volume.

FRICITION LOSS COEFFICIENT TABLE (C)

<table>
<thead>
<tr>
<th>HOSE SIZE</th>
<th>COUPLING SIZE</th>
<th>COEFFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4”</td>
<td></td>
<td>1100</td>
</tr>
<tr>
<td>1”</td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>1 3/4”</td>
<td>1 1/2”</td>
<td>15.5</td>
</tr>
<tr>
<td>2”</td>
<td>1 1/2”</td>
<td>8</td>
</tr>
<tr>
<td>2 1/2”</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>3”</td>
<td>2 1/2”</td>
<td>0.8</td>
</tr>
<tr>
<td>Two 3”</td>
<td>2 1/2”</td>
<td>0.2</td>
</tr>
<tr>
<td>4” LDH</td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td>5” LDH</td>
<td></td>
<td>0.08</td>
</tr>
</tbody>
</table>

ELECTRIC PRIMING METHOD

1) Close all discharge valves, drains, pump cooler, and all intakes.
2) Open the hydrant or tank to pump valve, depending on water source.
3) Open the throttle to approximately 1,000 rpm. Pull the primer handle and the discharge gauge should rise when the pump is primed.
4) The primer motor should not be engaged for more than 30 seconds per attempt.
5) If the pump does not prime in the appropriate amount of time (30 seconds), check the water source for possible leaks. Try to prime the pump again.
**MANUALLY PRIMING PUMP**

1) Put the engine in pump gear.
2) Open the valve from the booster tank to the pump.
3) Remove the cap from the highest 2 1/2” discharge outlet.
4) Open the 2 1/2” valve until water discharges.
5) Close the 2 1/2” valve.
6) The pump should be primed.

**SETTING THE RELIEF VALVE**

1) Turn the relief valve control all the way in.
2) Using the hand throttle, increase the pump pressure to 5 psi above the highest correct discharge pressure.
3) Turn the relief valve to the “ON” position is so equipped.
4) Turn the relief valve control out slowly, until the pressure gauge shows a drop in pressure.
5) Re-adjust the relief valve until the pressure is 5 psi above the highest correct discharge pressure.
6) Using the hand throttle, lower the pump discharge pressure to the proper setting (5 psi less than the relief valve setting).

**NOTE:** Any other lines flowing at pressures below the relief valve pressure setting will have to be controlled by unlocking that particular discharge gate, pinching it down to the correct discharge pressure, and then re-locking it.

**NOTE:** At least one 1 3/4” line or larger must be flowing to set the relief valve. The booster line CANNOT be used to set the relief valve.

**EXAMPLE:** Correct discharge pressure is 150 psi.

1) Turn the relief valve all the way in.
2) Set the discharge pressure to 155 psi with the hand throttle.
3) Turn the relief valve out to 155 psi relief valve pressure.
4) Set engine pressure to 150 psi using the hand throttle.
5) The engine pressure is now 150 psi and the relief valve setting is 155 psi.

**NOTE:** The proper relief valve setting will always be 5 psi above the highest pump discharge pressure.

**CALCULATING ADDITIONAL WATER AVAILABLE FROM A HYDRANT**

**FIRST DIGIT METHOD**

1) Find the difference in psi between the static and residual pressures.
2) Multiply the first digit of static pressure by 1, 2, or 3 to determine how many additional lines of equal flow (gpm) may be added as explained below.
3) If the psi drop is equal to or less than the first digit of the static pressure multiplied by 1, three additional lines of equal flow (gpm) may be added.
4) If the psi drop is equal to or less than the first digit of the static pressure multiplied by 2, two additional lines of equal flow (gpm) may be added.
5) If the psi drop is equal to or less than the first digit of the static pressure multiplied by 3, one additional lines of equal flow (gpm) may be added.

The following example demonstrates how to compute additional water at a hydrant by the first-digit method.

**EXAMPLE:**

A pumper is supplying one line with 250 gpm.

<table>
<thead>
<tr>
<th>Static pressure reading was 65 psi</th>
<th>Difference in psi=Static Pressure – Residual Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual pressure reading is 58 psi</td>
<td>Difference in psi = 65-58</td>
</tr>
</tbody>
</table>

Difference in psi = 65-58
Difference in psi = 7

First digit of static pressure x 1
6x1=6
6x2=12
6x3=18
7 is not less that 6 but is less than 12 (2 x 6), so 2 more lines at 250 gpm each can be added.
NATIONAL FIRE ACADEMY FIRE FLOW FORMULA

- Multiply the length of building by the width.
- Divide by 3 \((L \times W) \div 3\).
- Times by the number of floors involved. \([ (L \times W) \div 3 \] x \# Floors
- The total is for 100% involvement.
- If 75% involved, multiply by 3/4.
- If 50% involved, multiply by 1/2.
- If 25% involved, multiply by 1/4.

PUMP PRESSURE FOR APPLIANCES (RULE OF THUMB)

<table>
<thead>
<tr>
<th>Appliance</th>
<th>GPM</th>
<th>PSI (FL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siamese</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Wye</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Solid Tip (handlines)</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Solid Tip (master stream)</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Puncture Nozzle</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>Engine 23 &amp; 31 (Ladder Pipe)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Akron Cellar Nozzle</td>
<td>250</td>
<td>100</td>
</tr>
<tr>
<td>Portable Monitor</td>
<td>500</td>
<td>120</td>
</tr>
<tr>
<td>Portable Sprinkler</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>In-Line Proportioner</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>Deck Gun (mounted or dismounted)</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Teleboom</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Ladder Pipe</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>95° Platform</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>135° Aerial</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Fog Nozzles (as rated)</td>
<td>100, 75, 50</td>
<td></td>
</tr>
</tbody>
</table>

GPM FLOW FROM SOLID BORE NOZZLES – RULE OF THUMB

<table>
<thead>
<tr>
<th>Tip Size</th>
<th>Type</th>
<th>PSI</th>
<th>GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4”</td>
<td>Hand Line</td>
<td>50 psi</td>
<td>100 gpm</td>
</tr>
<tr>
<td>7/8”</td>
<td>Hand Line</td>
<td>50 psi</td>
<td>150 gpm</td>
</tr>
<tr>
<td>1”</td>
<td>Hand Line</td>
<td>50 psi</td>
<td>200 gpm</td>
</tr>
<tr>
<td>1 1/8”</td>
<td>Hand Line</td>
<td>50 psi</td>
<td>250 gpm</td>
</tr>
<tr>
<td>1 1/4”</td>
<td>Hand Line</td>
<td>50 psi</td>
<td>300 gpm</td>
</tr>
<tr>
<td>1 1/4”</td>
<td>Master Stream</td>
<td>80 psi</td>
<td>400 gpm</td>
</tr>
<tr>
<td>1 3/8”</td>
<td>Master Stream</td>
<td>80 psi</td>
<td>500 gpm</td>
</tr>
<tr>
<td>1 1/2”</td>
<td>Master Stream</td>
<td>80 psi</td>
<td>600 gpm</td>
</tr>
<tr>
<td>1 5/8”</td>
<td>Master Stream</td>
<td>80 psi</td>
<td>700 gpm</td>
</tr>
<tr>
<td>1 3/4”</td>
<td>Master Stream</td>
<td>80 psi</td>
<td>800 gpm</td>
</tr>
<tr>
<td>2”</td>
<td>Master Stream</td>
<td>80 psi</td>
<td>1000 gpm</td>
</tr>
</tbody>
</table>

HOSE LOADS (LOADING 4” & 5” IN THE HOSEBED)

1) The first coupling is placed in the front of the hose bed.
2) The 4” or 5” hose is loaded in the flat load. Load the first section with the fold in the front of the hose bed 12 to 14 inches short of the front of the hose bed.
3) The next coupling should be placed in the front of the hose bed ahead of the folds in the hose.
4) All couplings will be placed at the front of the hose bed no matter where they come in the hose load.
5) The second tier of hose should be folded so the bend in the hose will be 4 inches short of the first layer. The third tier will be the same as the first, continue to lay the hose in folds progressively across the bed to complete the load.
FORWARD LAY 3” HOSE (FORWARD LAYOUT WITH 3” FEEDER LINE)

1) Apparatus Operator spots apparatus approximately 20 feet past the hydrant.
2) On orders from the officer, firefighter disembarks engine and gives a signal when hose is secured around hydrant.
3) On orders from the officer, operator proceeds to the fire and spots apparatus in the most beneficial position for exposure and/or fire attack.
   NOTE: spot apparatus in consideration of other responding apparatus.
4) Operator places apparatus in neutral; set parking brake; engage pump; shift transmission into drive. (This will change the transmission from road gear to pump gear)
5) The officer will place the hose clamp on the 3” feeder line. If 2 lines are used, 1 line will be connected to an intake.
6) Operator checks to ensure pre-connect is clear of compartment and apparatus.
7) On orders from the officer, operator charges appropriate discharge using water from booster tank or supply line.
   NOTE: after the first line has been charged and is at correct pump discharge pressure, relief valve must be set.
8) Operator will then connect feeder line to intake, then remove hose clamp. Once water has reached intake valve, operator will open intake valve then adjust pressure accordingly.

FORWARD LAY 4” HOSE (FORWARD LAYOUT WITH 4” FEEDER LINE)

1) Apparatus operator spots apparatus approximately 20 feet past hydrant.
2) On orders from the officer, firefighter disembarks engine and gives a signal when hose is secured around hydrant.
3) On orders from the officer, operator proceeds to the fire and spots apparatus in the most beneficial position for exposure and/or fire attack.
   NOTE: spot apparatus in consideration of other responding apparatus.
4) Operator places apparatus in neutral; set parking brake; engage pump; shift transmission into drive. (This will change the transmission from road gear to pump gear)
5) Operator disembarks engine and chocks wheels. Operator proceeds to the rear of the apparatus to disconnect supply line and connects to intake/suction.
   NOTE: supply line should be connected on operator side when possible.
6) Operator checks to ensure pre-connect is clear of compartment and apparatus.
7) On orders from the officer, operator charges appropriate discharge using water from booster tank or supply line.
   NOTE: after the first line has been charged and is at correct pump discharge pressure, relief valve must be set.

HOSE CLAMPS

- The officer will place hose clamp 6 feet on the supply side from a coupling and a minimum of 20 feet from tailboard. It is not recommended to use a hose clamp with Large Diameter Hose. It will slide on the hose when loosened.

4” HOSE INTAKE CONNECTION

1) Put pump in gear.
2) Open the tank to pump valve and pump proper pressure.
3) Set relief valve.
4) Call for water if mobile radio is used or signal to the plug catcher if possible.
5) Bleed air from the 4” hose.
6) Open the intake valve and close the tank to pump valve slowly (10 second rule).
7) Re-adjust the pump pressure and set the relief valve.
HYDRAASSIST OPERATION

1) First engine will spot at the hydrant for hydrant connection using Hydra-assist. Firefighter disembarks engine for hydrant connection. Engine proceeds to fire. Handle on Hydra-assist should point to the “B” position after connection is made and before hydrant is opened. (Figure 1)

2) Firefighter opens the hydrant using the 10 second rule. Firefighter returns to engine company.

   NOTE: 10 second rule should take about 10 seconds to open/close a valve to prevent damage to plumbing.

3) Second engine will spot at the hydrant with largest discharge on the hydrant side. Spot apparatus for soft suction connection.

4) Operator will set park brake, then connect 5” soft suction to side “C” of the Hydra-assist. Operator will then connect soft suction to the 5” intake.

5) Operator will attach 25 feet of 4” hose to side “D” of the Hydra-assist. The 4” hose is connected to the largest discharge.

6) Operator will turn handle on the Hydra-assist to the “D” position. Operator will open the intake valve and the discharge valve, then engage the pump.

7) Second engine operator will pump friction loss plus 20 psi for residual pressure to the first engine.

8) Contact the first engine by radio to confirm residual pressure is 20 psi or above.

   NOTE: pump discharge pressure should not exceed 200 psi.

REVERSE LAY

1) Operator will spot apparatus approximately 20 feet past the connection point.

2) Operator will set park brake, disembark engine, and assist with unloading necessary equipment.

3) Firefighters will pull attack hose and advance toward the fire.

4) Firefighter(s) fold approximately 10 feet of hose back on top of supply line and secures with knee.

   NOTE: for safety reasons, the Storz coupling should be in front of the firefighter. Upon signal, operator will proceed to hydrant.

5) Firefighter(s) will connect supply line to manifold, then assist in advancing attack line(s) toward the fire. When connecting to a manifold, master stream, such as a portable monitor or aerial device, connection can be made as soon as the supply line does not have residual pull.

6) Operator will spot engine for soft suction connection. The operator should turn wheels approximately 45 degrees away from the hydrant. Operator will make connection to hydrant and to the intake with 5” soft suction. Operator will then open the hydrant using the 10 second rule.

   NOTE: Take static pressure reading

7) Operator will disconnect the feeder line and connect to the 3” large discharge.

8) Operator will open discharge valve allowing water to start flowing to purge line.

9) Operator will chock wheels, return to the engine, and engage the pump.
FULL STRIP / PARTIAL STRIP

- In cases where necessary to place the pumping unit at water source (i.e.: Reverse Lay), the equipment needed to carry out fire fighting operations will have to be removed from rig. According to IFSTA Hose Practices, there are two options for type and amount of equipment to be removed.

- When complete complement of equipment is needed to support fire fighting operations for extended period of time, “Full Strip” is made. When a less extensive complement is needed, a “Partial Strip” is made.

- The removal of this equipment will cause some delay in initial attack; however, a way to expedite task is to assign specific pieces of equipment to each crew member so the job is done in shortest time. Planning ahead will insure that needed equipment will be at the scene and not left on the pumping unit.

PUMPING TO A SPRINKLER/STANDPIPE CONNECTION

1) Operator will spot apparatus approximately 20 feet past sprinkler/standpipe connection and set parking brake.

2) Engine crew disembarks engine and offloads enough line to make a sprinkler/standpipe connection. Adapters needed for 4” hose; Storz to 2 ½” male on a 30 degree elbow. Adapters needed for a 3” hose is a 2 ½” double male.

3) On orders, operator will proceed to hydrant to make connection.

4) Firefighter(s) will make connection to sprinkler system/standpipe after a few flakes have deployed off engine and there is no residual pull on the hose.

5) Operator spots apparatus for soft suction connection. Turn wheels 45 degrees away from hydrant. Set parking brake, disembark engine and gather necessary tools to make steamer connection.

NOTE: only use 5” soft suction to steamer to make this connection. Operator will open hydrant and take static reading.

6) Operator will break the line at tailboard and connect to appropriate discharge.

SPRINKLERS: Operator waits for orders before turning water in.

STANDPIPES: Open the discharge and allow water to purge the line.

7) Chock wheels and engage the pump.

8) Operator pumps 125 psi plus friction loss, plus 5 psi per floor above the 1st floor.

NOTE: do not exceed 200 psi as per system is rated at 500 gpm.

RELAY PUMPING 4” HOSE (1,000 GPM)

1. There needs to be an engine every 900 feet.

2. 1st engine should connect to the hydrant with the Hydra-assist and lay out 900 feet of hose, stop and connect at that point, and plugman should turn in water at this time.

3. 2nd engine will connect to 1st engine and lay out 900 feet of hose and connect at that point. 1st engine should turn water in at this time.

4. The process shall continue until the lay out is completed. The next available engine not in the relay operations will connect to the Hydra-assist at the hydrant.

5. All engines in the relay will pump friction loss plus 20 psi for residual.

EXAMPLE: (F.L. PLUS 20 PSI, 180 + 20 = 200 PSI)
PRECONNECTS

The basic hose loads currently recognized on the Oklahoma City Fire-Rescue Service for Preconnects are the Triple Layer, Minuteman, and the Accordion Fold.

These loads are for 1 ¾”, 2”, and 2 ½” hose with either 150’ or 200’ lengths. The Triple Layer can be used on rear deployment or crosslay. The Minuteman load is used exclusively on rear deployment loads. The Accordion load is used on the fender mounted Quick Deployment Load and the E-One Jump Line.

All loads should be pulled in a safe manner, aware of the surroundings such as footing and other firefighters. Speed is not as important a factor as is personnel safety. Practice in pulling these loads in a steady fashion is desirable.

TRIPLE LAYER LOAD

1) Connect all drained hose and extend either to the rear or side of the apparatus.
2) Connect the female coupling to the discharge.
3) Pick up the hose at a point $2/3$ of its length towards the nozzle and carry to the discharge connection. This forms $3$ layers that should be stacked on top of each other. This may take some adjusting of layers to achieve this.
   a) Extend hose straight from the apparatus.
   b) At $2/3$ distance from apparatus, pick up hose and return to the apparatus.
   c) Stack hose three layers high and flake into hose bed in flat layers until the hose is loaded.

MINUTEMAN LOAD (REAR HOSE BED ONLY)

1) Connect the female end of the first section of hose to a $1 ½”$ outlet. Place one layer of hose in the bed, while the remainder of the section is to be accordion folded on edge, towards the front of the hose bed. Leave a $2$ to $3$ foot tail on the male end and set aside.
2) Place additional sections of hose in the bed starting with the nozzle to the inside at the bottom.
3) Couple the free ends of the hose and place into hose bed.

ACCORDION LOAD

1. Drain and lay out hose to the side of the apparatus. If it is the jump line, lay hose to the front of the apparatus.
2. Connect the female end to the discharge.
3. Lay the hose on edge, beginning at the back of the tray and zig-zag the hose back and forth, keeping the couplings away from each other. For the jump line, fold the hose in the box flat.
4. Continue until the hose is loaded.

PULLING A TRIPLE LAYER LOAD

1. Pull the nozzle and folds of the first tier and place over shoulder facing away from the load.
2. Walk away from the apparatus until the entire load is pulled from the bed.
3. Drop the folded end from the shoulder and advance nozzle to the fire.
4. Be sure all the hose is laid out and air is expelled before advancing the hose line to the fire.

PULLING A MINUTEMAN LOAD

1. Remove the hose load from the bed onto the shoulder.
2. Walk straight from the apparatus approximately $50$ feet.
3. Turn toward the incident and allow hose to lay of shoulder.
4. Be sure all the hose is laid out and air is expelled before advancing the hose line to the fire.
PULLING A QUICK DEPLOYMENT LOAD

1. Open the door on the Quick Deployment tray (Be sure the compartment doors are closed before opening the tray door).
2. Place the nozzle and one flake of hose over the shoulder and advance toward the fire.
3. Be sure all the hose is laid out and air is expelled before advancing the hose line to the fire.

PORTABLE SPRINKLER SYSTEM

The portable sprinkler system is primarily used to restrict the spread of fire in an enclosed area such as an attic or cockloft. It can aid in the control and extinguishment of fire underneath floors, around floor furnaces, and inside walls. It also can be used very effectively as a water curtain device in attics and cocklofts. Its use can also reduce the convection of heat currents, and cool the temperature of unburned fuel gases.

One set consists of four nozzles, 4 ten-foot sections of 1 ½” hose equipped with female connections on each end, and a 1 ½” end cap. Each nozzle has a ½” inside diameter and is 18 inches in length. Each nozzle flows approximately 25 gpm at 100 psi nozzle pressure. Therefore, we need to pump 125 psi plus friction loss in the feeder line. This will allow 25 psi friction in the wye and portable sprinkler assembly. With one set you should be able to cover an area approximately 40-50 feet in length. By using 2 sets in series, you can cover an area approximately 90 feet in length. It is not feasible to use two sets with a 1 ½”, 1 ¾”, and 2” diameter feeder lines because of reduced water supply.

It is important that the system be supplied through a wye off the feeder line to provide more adequate volume of water, especially when employing additional units. The volume of water being delivered through the nozzles should be checked occasionally to ensure adequacy. These units may be advanced and be an aid to extinguishment as the fire diminishes.

If possible, a hose roller or salvage cover should be used where the feeder line comes over the parapet wall or roof edge to prevent the line from being kinked at this point. This will also prevent chaffing the feeder line. Do not hammer the nozzles into the roof. Always use a pickhead axe or a hammer headed pick to make the hole to place the nozzles in.

BUNDLING PORTABLE SPRINKLERS

1. Starting with the nozzle and cap, slip nozzle into holder, beginning with the buckle end. Connect the first ten-foot section of hose, allowing hose to lay to the left of the holder.
2. Place the 2nd nozzle into the same end of the holder, directly on top of 1st nozzle. Bring first hose to your left and connect to 2nd nozzle, leaving the coupling loose so hose can be adjusted later to lay on the same plane. Connect 2nd ten-foot section of hose to 2nd nozzle and lay this section to your right.
3. Notice the 3 nozzle tip holders on the harness. Place the 3rd nozzle directly on top of the 2nd nozzle from the same direction. Note one difference: The nozzle tip will be threaded into the middle part of the holder. Now connect hose #2 on your right to nozzle #3. Take hose #3 and connect to left side of nozzle #3.
4. Place nozzle #4 in the holder in the same way you placed #3 nozzle with tip being placed in to the middle part of nozzle tip holder. Then bring hose #3 back and connect to left side of nozzle. Connect hose #4 to right side of nozzle #4.
5. Now all nozzles should be directly on top of the other with all stems pointing the same direction. Next, offset each tee about 1 inch so tees will stack closely. Buckle the harness around nozzles lengthwise, leaving slightly lose so that couplings can be tightened after hose has been aligned to lay on its edge on the same plane. Tighten harness strip completely.
6. Notice that you will have 2 ten-foot sections of hose to each side of your nozzles. Roll each of these along the sides of the harness, adjusting about 6 flakes in each ten-foot section and the length of your holder. Buckle the arm strap around folds. Adjust folds again for uniformity and completely tighten.