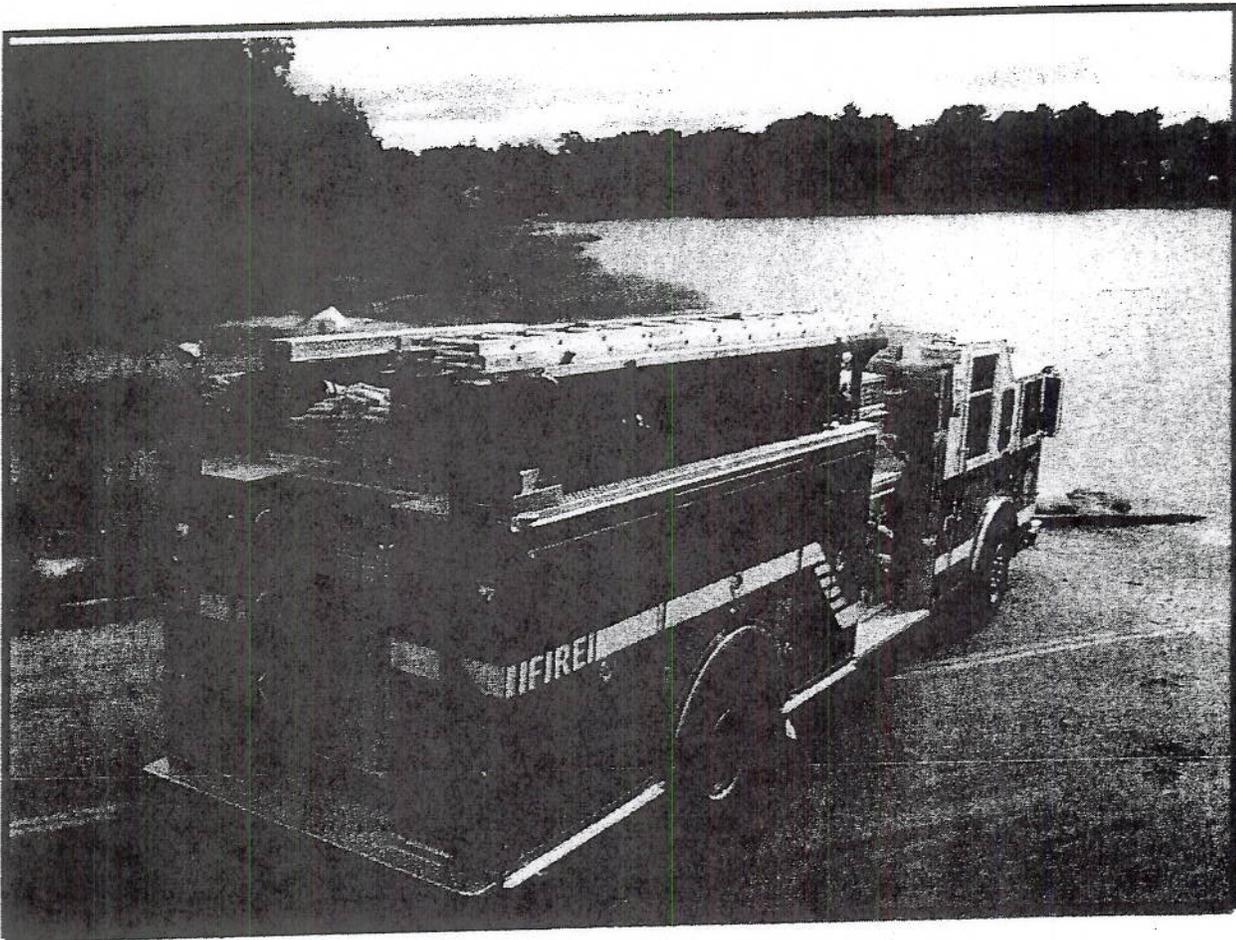


MOTOR PUMP OPERATOR



Department of Fire Services
Massachusetts Firefighting Academy

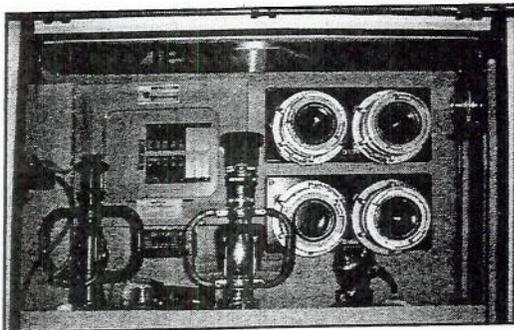
STUDENT GUIDE



Motor Pump Operator



Module 5 – Nozzles and Appliances



Motor Pump Operator
Module 5

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Solid Stream

- Fixed orifice, smooth bore nozzle which produces an unbroken stream
- Produces a stream that is compact and has little shower or spray
- Has good reach
- Made to operate in a range of 40 – 60 psi with 50 psi being the accepted standard

Motor Pump Operator
Module 5

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Solid Stream

- **Advantages**
 - Greater reach
 - Greater penetration
 - Less likely to disturb normal thermal layering of heat and gases during interior attack
- **Disadvantages**
 - Set stream pattern
 - May not be used for foam application
 - Less heat absorption per gallon delivered
 - Must be fully opened to get full gpm/psi delivered

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Module 5

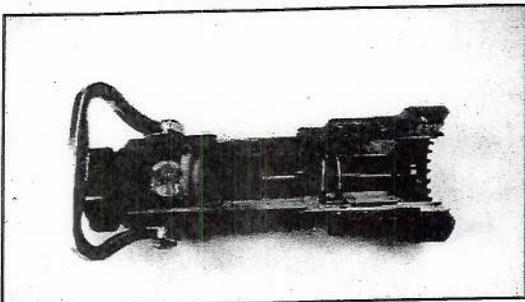
8 - 4

Combination Nozzle

- Produces a fog stream of fine water droplets
- Can be adjusted to different patterns
- The fog pattern is good for heat absorption
- Made to operate in a range of 50 – 100 psi
- Fixed gallonage
- Adjustable gallonage
- Automatic

Motor Pump Operator
Module 5

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Combination Nozzle

Motor Pump Operator
Module 5

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Combination Nozzle

- **Advantages**
 - Discharge pattern may be adjusted
 - Gallonage may be adjusted
- **Disadvantages**
 - Does not have the reach or penetration power of solid streams
 - Fog stream is more susceptible to wind current
 - When improperly used during interior attack, can cause the spread of fire, create heat inversion and cause steam burns
 - Need to operate fully open to get full gpm/psi

Motor Pump Operator
Module 5

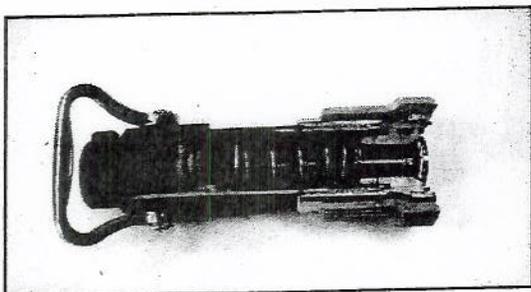
5-7

Automatic Nozzles

- Combination nozzle with a sensing device that maintains a constant 100 psi
- May use slide valve or ball valve
- Automatic adjustable gallonage
- Requires minimum contact with pump operator
- Able to control nozzle reaction at the nozzle
- Handlines: 1-1/2" – 3" hose
 - 50 – 350 gpm (full range)
 - 60 – 200 gpm (mid range)

Motor Pump Operator
Module 5

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Automatic Nozzle

Motor Pump Operator
Module 5

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Automatic Nozzle

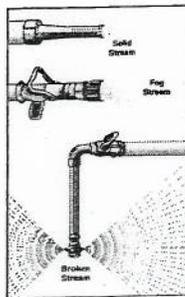
- Advantages
 - Nozzle operator has flow control
 - Consistent hard-hitting streams
 - Maintains optimum nozzle pressure at all times
 - Will adjust to the flow available
 - If flow is increased, the gpm's will automatically increase pressure
 - Will maintain maximum reach for available flow

Motor Pump Operator
Module 5

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Broken Stream Nozzle

- Produces coarsely divided drops of water
- Good heat absorption
- Examples:
 - Piercing Nozzle
 - Water Curtain Nozzle
 - Bresnan Nozzle
 - Cellar Nozzle
 - Chimney Nozzle
 - Navy / Rockwood Nozzle



Motor Pump Operator
Module 5

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Master Stream Appliances

Motor Pump Operator
Module 5

5 - 12

Master Stream Appliances

- Master streams are discharged from appliances using tips larger than 1-1/4"
- May be either solid stream or fog
- Solid tip master streams should be operated in a range of 60 – 80 psi
- Combination tip master streams are operated at 50 – 100 psi
- Friction loss in master stream appliances starts at 10 psi
- The age of the appliance may require more psi with high flows at the tip

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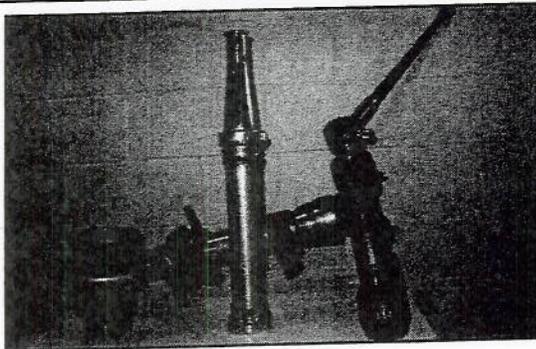
5 - 13

Master Stream Appliances

Ladder Pipe
Monitor
Deck Gun
Portable Unit

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Module 5

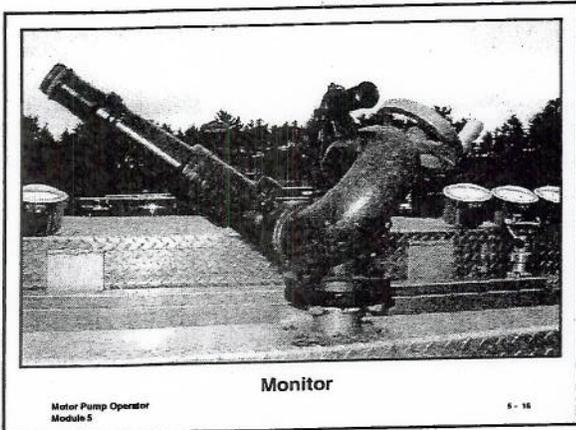
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Ladder Pipe

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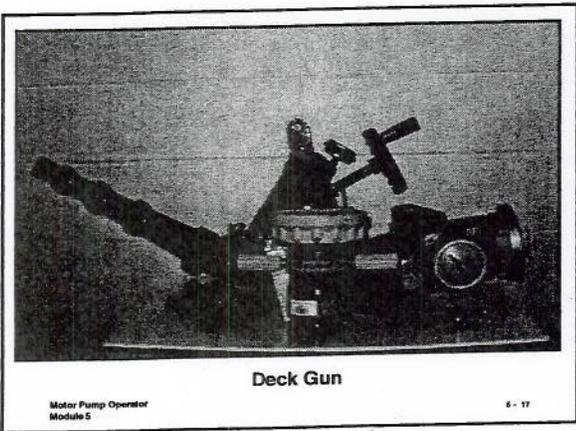
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Monitor

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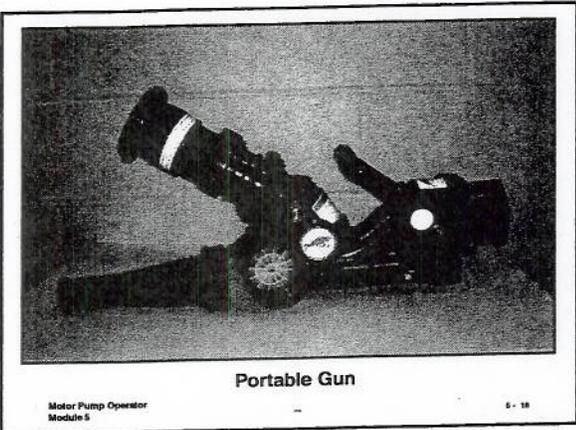
5 - 16



Deck Gun

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Module 5

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Portable Gun

Motor Pump Operator
Module 5

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Pressures for Ladder Pipe Operations

- Nozzle Pressure
 - 80 or 100 psi
- Friction Loss in Gun and Siamese
 - 15 psi
- Friction Loss in 3" Hose
 - Based on size of tip or model of combination nozzle
- Friction Loss due to Elevation
- Friction Loss in Supply Line

Motor Pump Operator
Module 5

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See manufacturer's
recommendations regarding
limitations

Check manufacturer's
specifications regarding the
weight capacity of the aerial

Motor Pump Operator
Module 5

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NFPA 1901 Section 20.G.2

- Ladder pipe with tip sizes 1-1/4" (400 gpm), 1-3/8" (500 gpm) and 1-1/2" (600 gpm) can be attached to the aerial
- Sufficient lengths of 3" or larger attack hose complying with Standard 1961 to reach between the installed ladder pipe and the ground with at least 10' of hose available on the ground with the ladder at full extension
- One hose strap for each ladder section
- Halyards to control the ladder pipe from ground level

Motor Pump Operator
Module 5

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Ladder Pipe Operation Safety

- 80 – 80 – 80 Rule
- Make sure ladder pipe and handle are securely locked
- No firefighters on the ladder
- Water on and off slowly to prevent water hammer
- Do not use guy wires to avoid twisting
- Never attempt to move the vehicle with the ladder pipe operating
- Watch ground around outriggers
- Check hydraulic system for overheating

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Module 5

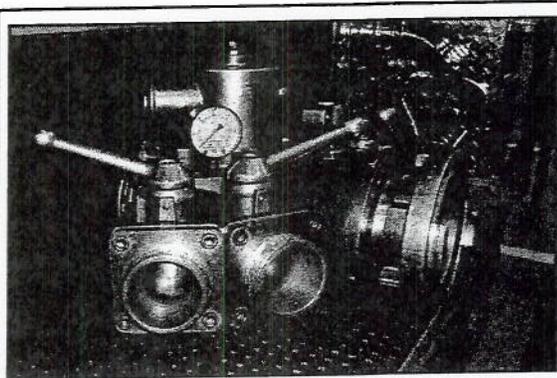
5 - 22

Ball Distributor Valve

- Used with Large Diameter Hose
- Also called portable hydrant or manifold
- Principle is same as a wye appliance
- Generally have a 4" or 5" inlet with 2 or more smaller
- May also be an outlet that is same size as the inlet

Motor Pump Operator
Module 5

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Module 5

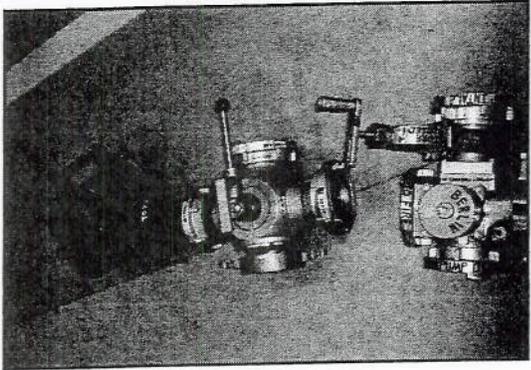
5 - 24

Hydrant Assist Valve

- Makes pumping the LDH line accessible and does not require the shutdown of the hydrant in order to set the pump
- With these valves there is no stoppage of water flow

Motor Pump Operator
Module 5

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Module 5

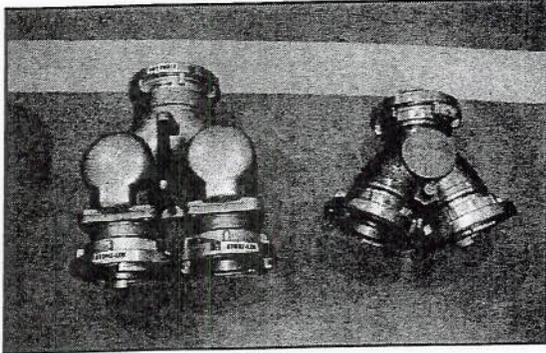
5 - 26

Wyes and Siamese Valves

- **Wye**
 - Divides one or more lines
 - Has one female and two or more lines
 - Used to divide a larger line into smaller lines
- **Siamese**
 - Combines two or more lines into one line
 - Has one male and two or more female connections
 - Used to combine several smaller lines into one larger one to supply a ladder pipe or ground gun

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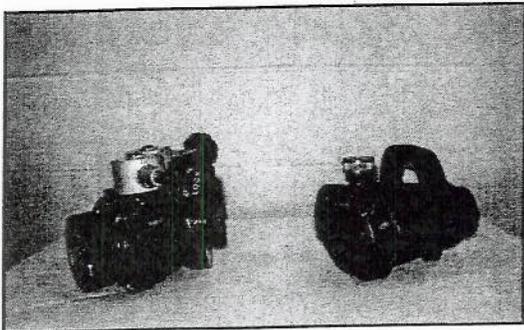
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Motor Pump Operator
Module 5

LDH Siamese

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Motor Pump Operator
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2-1/2" Siamese

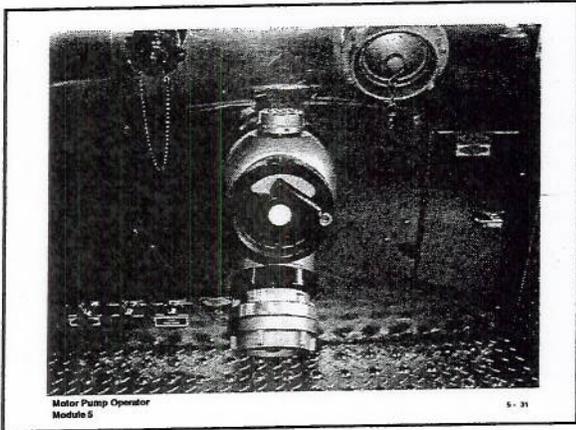
5 - 24

Gated Incoming Relief Valves

- Designed to release all air coming into the pump from LDH
 - Must be opened manually
- Should be left open when the pumper is put back in service
- Newer type are self-closing
 - Paddle wheel closes the bleeder valve
- Female end comes in 4", 4-1/2", 5" or 6"
- Storz side comes in 4", 5" or 6"
- Older type pressure relief is on the pump side, not the hose side

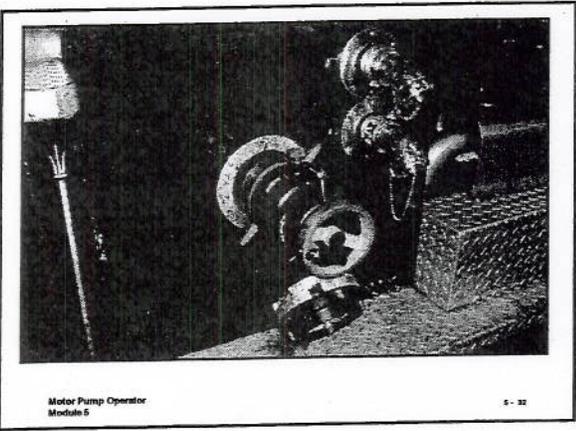
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Module 5

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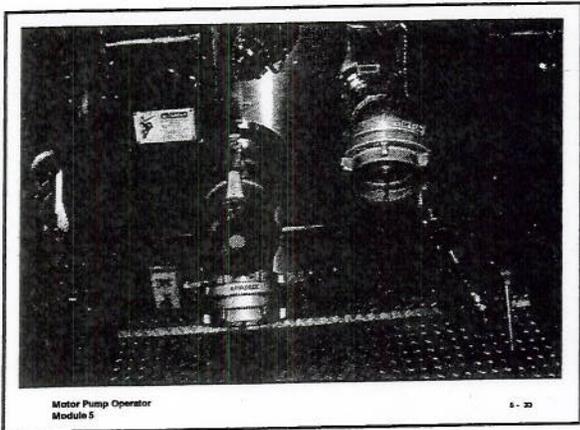
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Motor Pump Operator
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Module 5

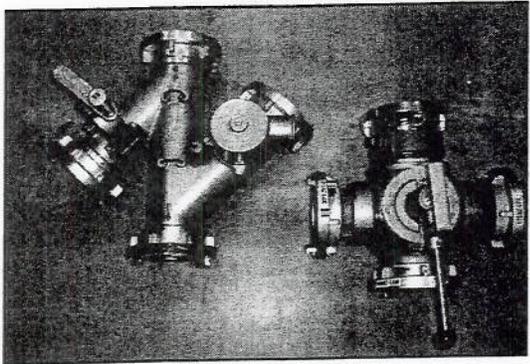
5 - 33

Relay Valves

- Z-Valve
- LDH inlet and outlet with 2 gated LDH valves and 1 clapper valve
- Used to increase the pressure in a long LDH relay
- Adapter to convert a Harrington hydrant assist valve into a relay valve

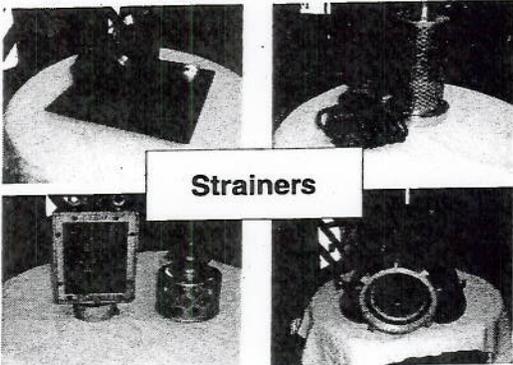
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Module 5

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Motor Pump Operator
Module 5

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Strainers

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Module 5

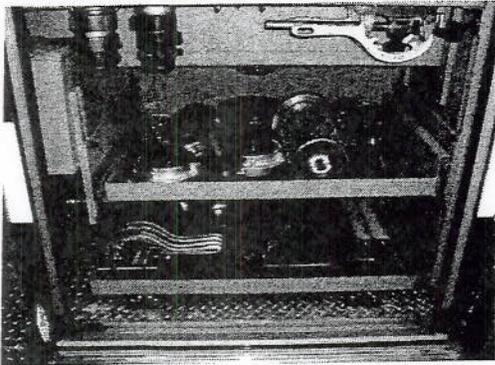
5 - 26

Adapters

NPT TO NST / or size	2-1/2" NST to 3"
2-1/2" NST to 4" Storz	1-1/2" Double Male
4" x 5" Storz	2-1/2" NST to 5" Storz
4-1/2" NST Female x 4" Storz	4-1/2" NST Female x 5" Storz
2-1/2" NST Female x 1-1/2" Male	2-1/2" Double Male
2-1/2" Plug Cap	2-1/2" Cap
Suction Caps	Reducer Caps

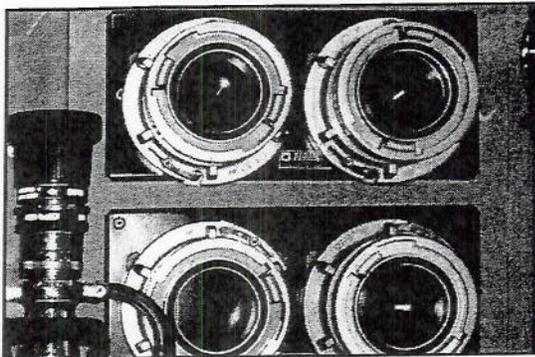
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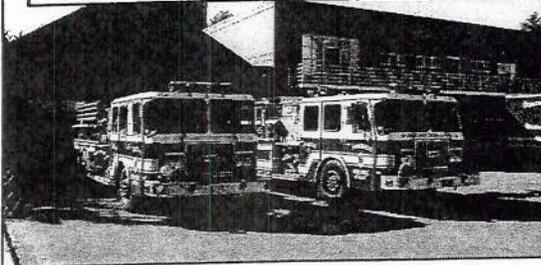


Motor Pump Operator
Module 5

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Motor Pump Operator



Module 6 – Drafting

Static Water Sources

- May be limited in total volume
- Limited by pump capacity and lift
- Class A Ratings
 - 100% @ 150 psi
 - 70% @ 200 psi
 - 50% @ 250 psi
- Test performed at draft with no more than 10' lift
- Test performed with 20' of hard suction

Motor Pump Operator
Module 6

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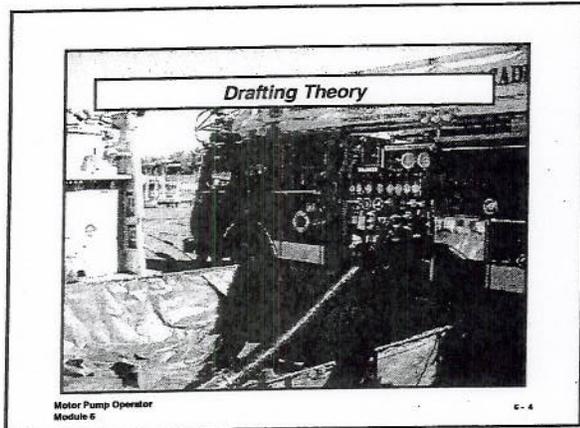
Limits of Suction Lift

1000 gpm pump – 20' of 5" suction
Net Pressure of 150 psi

4' lift	1160 gpm
10' lift	1000 gpm
16' lift	790 gpm
22' lift	485 gpm

Motor Pump Operator
Module 6

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Atmospheric Pressure

- **Maximum Theoretical Lift**
 - 14.7 psi
 - 2.3' / psi
 - 33.9 feet
- **Maximum Actual Lift**
 - 25 feet

Motor Pump Operator Module 6 6-5

Effect of Altitude

Elevation Above Sea Level	Loss of Lift
1000'	1.22'
2000'	2.38'
3000'	3.50'
4000'	4.75'

Motor Pump Operator Module 6 6-6

Priming Requirements

- Must raise water 10' through 20' of hard suction in not more than 30 seconds
 - 45 seconds for pumps 1500 gpm or larger
- Must develop 22 inches of mercury up to an elevation of 1000' above sea level
- Pump must hold vacuum for at least 10 minutes with a loss of not more than 10 inches of Hg

Motor Pump Operator
Module 6

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Types of Priming Devices

- Rotary (Positive Displacement)
- Engine Manifold – Gas Motors
- Exhaust Ejector – Portable Pumps

Motor Pump Operator
Module 6

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Limitations in Hard Suction

Flow capability 1000 gpm pumper
20' – 30' suction hose @ 150 psi net

Lift	5" Hose	6" Hose
4'	1160 gpm	1345 gpm
10'	1000 gpm	1170 gpm
16'	790 gpm	960 gpm
22'	485 gpm	590 gpm

Motor Pump Operator
Module 6

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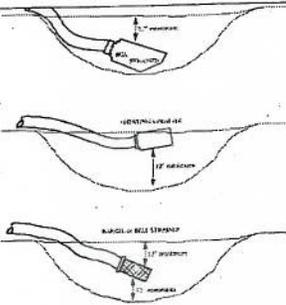
Drafting Procedure

- Spot the truck
- Connect the hard suction
 - 12" off the bottom and from the surface
- Close all drains and discharges
- Prime until a steady discharge or constant pressure reading
- If no prime, check drains, discharges and suction hose
- When primed, increase throttle and open discharges slowly

Motor Pump Operator
Module 6

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Strainer Placement



Motor Pump Oper
Module 6

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System Check When Pump Will Not Draft

- Primer Operation
- All Suction Connections
- All Discharge Connections

Motor Pump Operator
Module 6

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Service Test

- Dry Prime Test
- Volume Test
- Pressure Test
- Net Pump Pressure
- Compute Lift & Suction Allowances
- Calculate Proper Hose Layouts
- Quick Lift Test
- Tachometer Test

Motor Pump Operator
Module 6

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Service Test Continued

- Pressure Gauge Test
- Compound Gauge Test
- Pressure Control Device Test

Motor Pump Operator
Module 6

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Additional Checks

- RPM While Pumping
- Engine Temperature
- Auxiliary Cooling System
- Oil Pressure
- Vibration
- Oil Levels
- Water Levels
- Shift Locks
- Transfer Valve

Motor Pump Operator
Module 6

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Cold Weather Operations

- Freezing
 - Pumps
 - Hoses
 - Gauges
 - Controls
 - Pump Operator

Motor Pump Operator
Module 6

6 - 16

- Speed of freezing varies according to:

- Temperature of area where apparatus is stored
- Outside temperature
- Wind speed
- Volume of water discharge
- Surface area exposed
- Duration of exposure

Motor Pump Operator
Module 6

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Freeze Prevention

- Pumps
 - Lines not shut down completely
 - Moving water does not freeze quickly
 - Drain booster lines, monitors etc.
 - Valves should be closed
 - Circulate water
 - All pumps leak water
 - Watch for icing
 - Check antifreeze levels

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Module 6

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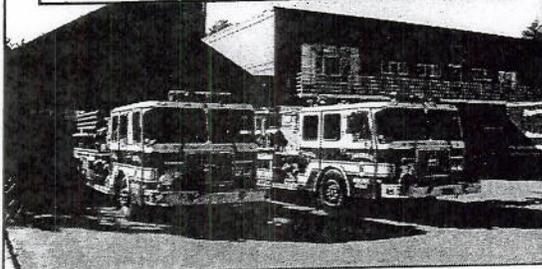
Freeze Prevention

- **Pump Operators**

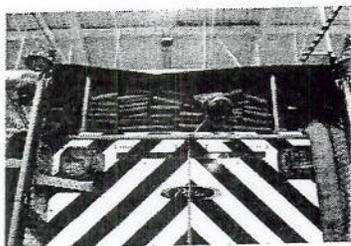
- Take time to dress properly prior to leaving the station
- Dress in multiple layers
- Move around – standing still allows the body to cool down
- Drink warm fluids



Motor Pump Operator



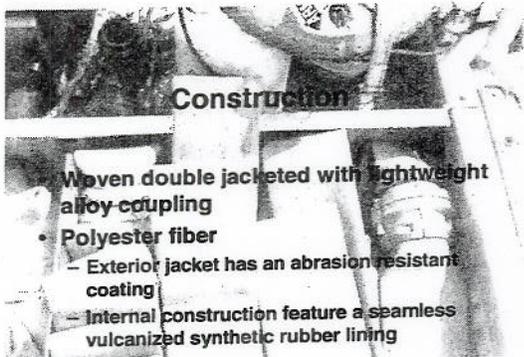
Module 7 – Large Diameter Hose



The use of large diameter hose is the concept of moving large volumes of water over greater distances in a hydraulically efficient manner with the use of minimal personnel

Motor Pump Operator
Module 7

7-2



Construction

- Woven double jacketed with lightweight alloy coupling
- Polyester fiber
 - Exterior jacket has an abrasion resistant coating
 - Internal construction feature a seamless vulcanized synthetic rubber lining

Motor Pump Operator
Module 7

7-2

Lengths

- Standard lengths are 100'
- Hose is available in lengths up to 200'

Weight and Coil Sizes	4"	5"
Coupled Weight 100'	78 pounds	103 pounds
Coil Size 100'	23 inches	23 inches
Full of Water	620 pounds	950 pounds

Motor Pump Operator
Module 7

7-4

Pressure Ratings

All four and five inch large diameter hose marked SUPPLY HOSE shall not be used at operating pressures exceeding 185 PSI when supplying fire department pumper from hydrants; when relaying water from pumper to pumper; and when directly supplying attack lines, master stream appliances, portable hydrants, manifolds and standpipe and sprinkler systems

Motor Pump Operator
Module 7

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Exception

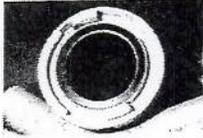
6" relay – supply hose shall not be used at operating pressures exceeding 135 PSIG

Motor Pump Operator
Module 7

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Couplings

- Storz quarter turn couplings are made of lightweight aluminum alloy
- Two types of non-threaded Storz couplings
 - Self-locking
 - Required on all new couplings
 - No locks
 - Older style and may twist open



Motor Pump Operator
Module 7

7-7

- Couplings should be kept clean and free from dirt
- Can be cleaned with a paintbrush and soapy water
- Should be serviced at least once a year or as recommended by the manufacturer



Motor Pump Operator
Module 7

7-8

- Most hose is field-repairable
- Couplings can be removed and replaced using allen wrenches
- Splice kits are available from the manufacturer
- All hose should be service tested after any maintenance procedure

Motor Pump Operator
Module 7

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Maintenance

- All hose should be proof-tested by the manufacturer
- All hose should be service tested by the user prior to being put in service
- Hose should be tested annually and checked for wear, abrasion etc.
- Records must be kept
- Hose does not have to be dried after each use and can be repacked when wet
- Hose should be brushed off and washed when dirty or contaminated

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Module 7

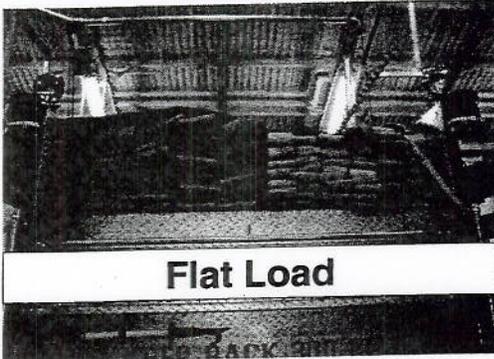
7- 10

Hose Loads

- A conventional hose body should be loaded with the hose laid flat
- Powered reels may be installed on a truck chassis
- A reel truck can lay out one mile of 4" hose in 10 minutes and it can be rewound at approximately 200' per minute

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Module 7

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Flat Load

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Module 7

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**IT IS EXTREMELY IMPORTANT
TO LOAD A REEL TRUCK
AS TIGHTLY AS POSSIBLE
TO AVOID HAVING THE LOAD
SETTLE OR "BELLY OUT"
WHEN SITTING FOR LONG
PERIODS OF TIME**

Motor Pump Operator
Module 7

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**From either a conventional hose
bed or from a reel truck, a speed
of 10 – 15 mph is recommended
when laying LDH**

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Module 7

7-14

Hose Bridging

- Fire apparatus can cross 4" hose provided the truck is not equipped with studded tires or snow chains
- The hose should be crossed one wheel at a time and fast enough so the hose is not skidded in front of the tires
- The driver should cross over the line and avoid running over couplings

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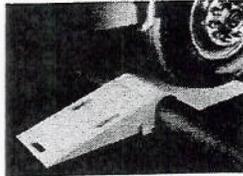
Small vehicles and cars should never be allowed to cross large diameter hose unless hose bridges are used.

The hose could be pushed in front of the tires and low-slung undercarriages and exhaust systems will cause damage.

Motor Pump Operator
Module 7

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There are commercially produced hose bridges available for hose up to 6.5 inches.



The newer ones are made of plastic and are lighter, but still cumbersome.

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Module 7

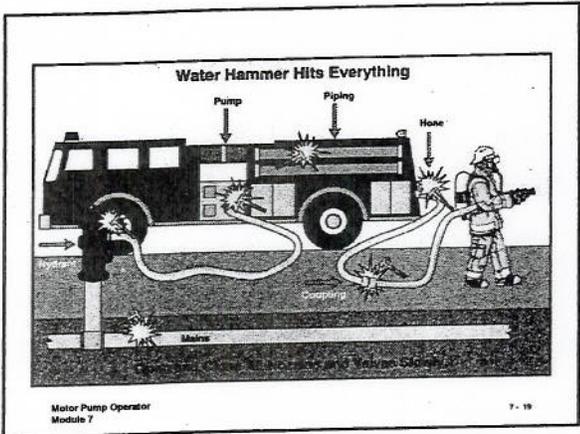
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Water Hammer is shock loading in hoses, nozzles, pumps etc. due to sudden movement of water.

It is caused by opening and closing valves, gates and nozzles quickly.

Motor Pump Operator
Module 7

7 - 18



Air Hammer is caused by the air that preceded water in the line; this compressed air exerts excess pressure on hose appliances, pumps and equipment.

Air hammer can destroy a pump.

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Module 7

7 - 20

Use the five-second rule when opening and closing any valve.

Take a full 5 seconds to operate it.

Motor Pump Operator
Module 7

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1000' of " hose will contain approximately 5300 pounds of water.

With 840 gallons a minute passing through the line, the water will attain a velocity of 14 mph.

A sudden stopping of the flow will have the same equivalent reaction as driving a 5300 pound vehicle into a brick wall at 14 mph.

Motor Pump Operator
Module 7

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Joining Couplings

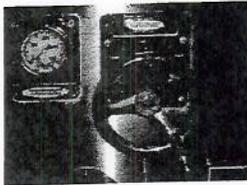
- When joining hoses together, turn couplings until a metallic click is heard
- Hose equipped with locks should have obvious indicators



Motor Pump Operator
Module 7

7 - 23

- All 3" or larger valves are required to be SLOW OPEN / SLOW CLOSE valves per NFPA standards
- These may be either manual or electrically operated with a manual back-up



Motor Pump Operator
Module 7

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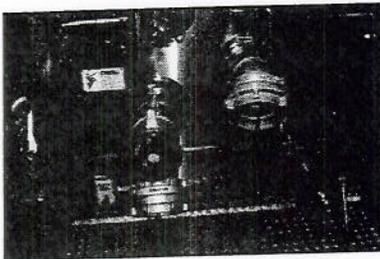
Operation of Large Diameter Hose

- Leave plenty of hose (15' – 20') so the connection will have a gradual bend to keep from kinking
- Use a 30° elbow to lessen the weight of the hose on the pump or hydrant
- Protect against water hammer with an incoming gated relief valve
- Maximum pressure shall not be more than 10 psi over the source it is connected to
- Incoming gated relief valves must have a bleeder valve to release air

Motor Pump Operator
Module 7

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The incoming gated relief valve is needed to protect the operator and the pump from air and water hammer



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Module 7

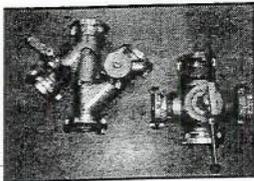
7 - 26

Charging Hose Lines

- Before charging, make sure the hose is placed so it won't obstruct incoming apparatus
- Charge at a rate under 75 psi
- ALL PRECAUTIONS MUST BE TAKEN TO PREVENT AIR AND WATER HAMMER
- Never exceed 185 psi pump pressure when operating in relay

Motor Pump Operator
Module 7

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Relay Valves

Can be inserted into LDH hose lays at predetermined intervals so that another pumper can be placed in the relay without shutting down the flow of water.

Some departments place a length of colored hose in the hose load so that the relay point can be readily identified.

Motor Pump Operator
Module 7

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Actual Friction Loss per 100'				
GPM	2-1/2"	3"	4"	5"
250	15	6	1.5	0.47
500	40	25	5	1.7
750	-	55	12	3.7
1000	-	100	20	6.6
1250	-	-	31	10
1500	-	-	42	14.5
2000	-	-	74	23

Motor Pump Operator
Module 7

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Friction Loss Rule of Thumb

4" Hose	
500 gpm	5 psi per 100'
700 gpm	10 psi per 100'
1000 gpm	20 psi per 100'
5" Hose	
1000 gpm	5 psi per 100'
1500 gpm	15 psi per 100'
2000 gpm	20 psi per 100'

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Warning:

Service testing is undertaken to determine the suitability of hose for continued use. Because there is potential for catastrophic failure during these tests, it is vital that adequate safety precautions be taken.

Testing Large Diameter Hose

- Inspect all hose, couplings and locks for physical damage
- Hose must be laid flat with no kinks
- Total length must not exceed 300'
- Any repaired or re-coupled hose must be tested one length at a time
- Hoseline shall not be connected directly to the pump discharge.
 - Use a short length to feed the line being tested

Testing LDH (cont.)

- Place an adapter and 2-1/2" playpipe on the end of the line to be tested, open the nozzle and slowly open the discharge to bleed off all the air
- When a solid stream is discharging, slowly close the nozzle and increase the pump pressure to 50 psi and slowly close the test gate
- Slowly bring the pressure up to the desired test pressure
- Increase at a rate not to exceed 10 psi per second
- Hold test procedure for 5 minutes for service and 1 minute for acceptance test

Table of Test Procedures for LDH

Diameter	Service Test	Proof Test
4" – 5"	200 psi max	400 psi
6"	150 psi max	300 psi

Service Test – hydrostatic test conducted by users on all in-service hose to determine suitability for continued use

Proof Test – shall only be conducted at the point of manufacture or at a facility properly equipped to perform such tests

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Points to Remember

- When laying line, do not bounce couplings or drag hose
- Always lay hose on the same side as the water source
- Do not allow vehicles to cross the line
- When the fire building is on the opposite side of the street, cross the road at the fire scene
- Make sure all LDH couplings are locked prior to charging the hose

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Points to Remember (cont)

- Whenever LDH enters a pump, it must be protected by an incoming pressure relief device equipped with a method to bleed the air
- Work with low pressures (75 psi) until you know what the total flow will be
- Always open and close lines slowly
- Do not fill LDH at any rate faster than you can walk

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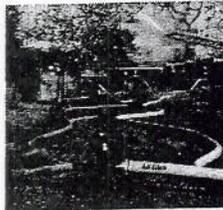
7-36

Never exceed 185 psi working pressure on LDH that is used as a water supply line (135 psi on 6" hose)

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Continuous training and pre-planning with your department and surrounding departments will allow for a smoother, more efficient water supply for all fireground operations



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Advantages of LDH

- **Lightweight**
- **Compact for easy handling and storage**
- **Non-absorbent; drying is not necessary**
- **No mildew or rot**
- **Sexless ¼ turn couplings**
- **Couplings attach with great speed and ease**
- **Reduces the need for multiple lines of 2-1/2" or 3"**
- **Personnel and time requirements are reduced**
- **Full pump capacity can be supplied**
- **Cost effective**

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Disadvantages of LDH

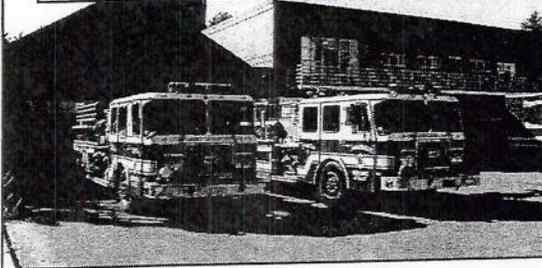
- Twisting can be a problem
- System that requires all components to deliver the maximum volume of water
- Hose can be easily damaged by misuse
- If a single line is broken, ALL water will be lost
- Once LDH is laid, it is almost impossible to relocate
- Conventional hose clamps cannot be used
- More susceptible to chemical damage

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Module 8 - Rural Water Supply

Rural Water Supply is used in:

- Out of hydrant areas
 - Rural / city areas where there are no domestic supplies
 - Highways
- Water main failure
- Water mains insufficient for required flow

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Module 8

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Rural water supply must be planned for:

- Target hazards
- Time of year
- Time of day
- Weather conditions
- Fill station access
- Placement of apparatus for continuous flow of shuttle vehicles

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Module 8

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Shuttle Components

- Fire Scene (Dumpsite)
- Water Supply (Fill Station)
- Transportation

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Module 5

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Dumping vs. Pumping

Pumping is the least effective method to off-load water due to:

- Piping of pump determines flow
- Friction loss in hose
- Time to set up pump
- Manpower

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Module 5

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Tankers / Tenders:

- Have large discharge valves (6" – 12")
- Discharge rates of 800 – 1500 gpm
- Average fill time for tanker is 3 minutes
- Most tankers use big lines to fill
- Pressure / vacuum tankers – fill and empty by themselves

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Water Hammer

- Open and close all valves S-L-O-W-L-Y
- Fill crew holds intake valve at tanker in the open position and holds it open during filling operations. This valve is not shut down until after the supply pump has shut down
- One pump fills one tanker at a time.
- Multiple stations can be set up

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Ways to Fill a Tanker

- Drafting
- Hydrant Direct
- Apparatus at a Hydrant
- Vacuum Tanker

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Apparatus at Draft

- If the pump that is going to the draft site stops at the fire to drop its tanks, it should leave a quarter of a tank on board for priming
- Position apparatus for drafting
- Remember to leave room for traffic flow
- Utilize dry hydrants if known and accessible
- Utilize floating strainers to minimize the whirlpool effect in shallow water

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Hydrant Direct

- Filling at hydrants is limited by capacity and pressure
- Utilize a pump on the hydrant for best results
- Dress hydrant or pumper for two fill stations
- Fill one tanker at a time
- Use full turn gates
- In place of $\frac{1}{4}$ turn for safest operation

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Hydrant with Pump In Line

- Pump panel should be on the road side for better visibility
- Use minimum amount of hose
- Have fill lines come off pump on opposite side for operator safety

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