The Massachusetts Department of Fire Services

Presents

Large Diameter Hose

Basic LDH Training
- 6 hours classroom
- 6 hours practical evolutions
Module Objective

The student shall develop a basic knowledge and understanding of the functions of large diameter hose and related appliances.

Enabling Objectives

The student will:
- Identify, prevent and understand the actions of water and air hammer on equipment and personnel.
- Identify different LDH construction.
- Identify proper procedures in the inspection, testing, maintenance and repair of LDH.
- Identify proper procedures in packing / repacking of LDH in hose beds and using hose reels.
- Identify the proper procedures in laying LDH from a hose bed and hose reel.

The student will:
- Discuss the proper procedure for charging LDH supply lines utilizing proper procedure to ensure safe operation of equipment and safety to personnel.
- Identify advantages and disadvantages between different sizes of LDH and conventional hose.
- Identify the use and operation of the appliances and accessories used with LDH.
- Demonstrate the proper procedure for charging LDH supply lines.
The student will demonstrate the operation of LDH in the following evolutions:

- Rural (Drafting)
- Relay Operations from Draft and Hydrant
- Hydrant Operations
- Fire Attack Supply Lines
- Fire Attack Master Stream Devices

**Brief History**

1950's
- Southwestern Fire Mutual Aid System Keene, NH credited with providing much of the stimulus for the use of LDH in the state of New Hampshire

1970's
- Chelsea Fire Department experimented with 4" hose and Storz couplings
- LDH was beneficial during the Great Chelsea Conflagration in 1973 and the Lynn Conflagration in 1981

The use of large diameter hose is the concept of moving large volumes of water over great distances in a hydraulically efficient manner with the use of minimal personnel.
LDH is used for water distribution in the city, rural areas and on limited access highways.

Functions of a Fire Dept. Pumper

- Provides water for firefighting
- Controls water
- Source of water to supply pumpers at the proper pressure

Provides Water for Firefighting

- Handlines
- Master stream appliances
- Supplement sprinkler system
- Supplement standpipe system
- Relay pumping to other apparatus
Controls
Water

- Friction loss
- Back pressure
- Forward pressure
- Excessive line pressure when other lines shut down
- Increase pressure

Water Sources

- Tank Supply
- Pressure Source
- Hydrants
- Dry Hydrants
- Static Sources

The Need for a Priming Device

- Absolute negative pressure is impossible to achieve
- Open waterway found in centrifugal pumps
- Remove air from the pump cavity and suction hose creating a higher outside pressure that pushes water up into the pump
Types of Priming Devices

- Positive Displacement Rotary Vane
- These will expel air with or without a lubricant
  - Dry used on the newer pumps
  - Oil may be used to reduce wear and priming time
  - Oil is no longer recommended
  - Environmentally friendly anti-freeze

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Priming Device

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Rotary Vane Pump

- Used as a priming device
- In a cycle, the rotor turns, and the vanes advance outward
- Space between the rotor and housing is filled with water
- Vanes then force air out the discharge
Centrifugal Pump

- Spinning action creates outward force
- An impeller is used
  - Water enters the eye and is thrown outward
Pressure Relief Devices

- Pumps must be equipped with a device to control pressure
- The devices operate in a range of 90 – 300 psi
- When activated, the pressure rise shall not exceed 30 psi

Types of Relief Devices

- Relief Valve
- Governor
- Gated Incoming Relief Valve
- Automatic Pressure Relief Devices installed on the pump

Relief Valve

Controls pressure by rerouting water from the discharge side of the pump
Total Pressure Master

Incoming / Outgoing relief valve made by Hale

Governor

Controls pressure controlling engine speed which in turn affects pump pressure

Manufacturer's Built in Relief Valve

Intake Pressure Relief Valve
Do Not Cap
Gated
Incoming
Relief Valve

Pressure can be set
for incoming LDH
lines

ICV's must be
adjustable from 90
psi - 185 psi
Standard Hydrant Installation

NFPA Hydrant Color Code

<table>
<thead>
<tr>
<th>Caps and Bonnet Color Code</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 499 GPM</td>
<td>Red</td>
</tr>
<tr>
<td>500 – 999 GPM</td>
<td>Orange</td>
</tr>
<tr>
<td>1000 – 1499 GPM</td>
<td>Green</td>
</tr>
<tr>
<td>1500 and up</td>
<td>Light Blue</td>
</tr>
</tbody>
</table>

Proper opening of the hydrant requires 18 – 22 turns of the operating nut
Friction Loss is part of the total pressure that is lost while forcing water through pipes, fittings, fire hoses, nozzles and adapters.

Friction Loss is lost energy!

Quality of Flow

LAMINAR FLOW
Water is moving in a straight line

TURBULENT FLOW
Water is moving in a swirling motion
**Efficient Carrying Capacity of Hose**

<table>
<thead>
<tr>
<th>Diameter (in)</th>
<th>Flow Rate (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2&quot;</td>
<td>100</td>
</tr>
<tr>
<td>1-3/4&quot;</td>
<td>150</td>
</tr>
<tr>
<td>2&quot;</td>
<td>200</td>
</tr>
<tr>
<td>2-1/2&quot;</td>
<td>300</td>
</tr>
<tr>
<td>3&quot;</td>
<td>500</td>
</tr>
<tr>
<td>4&quot;</td>
<td>1000</td>
</tr>
<tr>
<td>5&quot;</td>
<td>2000</td>
</tr>
</tbody>
</table>

**Static Pressure:**

Stored energy that is available to move water through pipes, hoses, and appliances.

- Shown on compound gauge with no water flowing.
- Static pressure remains the same at any point in the closed system if elevation is the same.
  - No matter what size hose or piping.

**Residual Pressure:**

Kinetic energy that is available to perform work. Water pressure that was not used to overcome back pressure due to elevation or friction loss.

- Incoming pressure shown on compound gauge with water flowing.
- Residual pressure is different at various points in the system due to friction loss and elevation.
Negative Pressure:
any pressure created in the fire pump or hard suction hose which is less than atmospheric
- Atmospheric pressure is 14.7 psi at sea level

Normal Operating Pressure:
pressure through water distribution system during normal consumption demands
- Fluctuates during day and night
- And also according to time of year

Line Pressure:
pressure needed to provide proper nozzle pressure with a given layout
Discharge Pressure:
in situations requiring multiple lines, the pump develops pressure for the highest line (greatest pressure)
- Gate back for all others to get the proper line pressure

Nozzle Pressure:
the pressure required at the nozzle to develop a proper fire stream from a nozzle
- Nozzle pressure and the tip size determine flow capability
- Standard nozzle pressure
  - Combination: 100 - 75 - 50
  - Solid Handline: 50
  - Solid Master Stream: 80

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
Limits of Suction Lift

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

<table>
<thead>
<tr>
<th>Lift (ft)</th>
<th>gpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1160</td>
</tr>
<tr>
<td>10</td>
<td>1000</td>
</tr>
<tr>
<td>18</td>
<td>790</td>
</tr>
<tr>
<td>22</td>
<td>485</td>
</tr>
</tbody>
</table>

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

Strainer Placement
System Check: Pump Will Not Draft

- Primer Operation
- All Suction Connections
- All Discharge Connections

Daily Inspection

<table>
<thead>
<tr>
<th>Engine Oil Level</th>
<th>Fuel Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiator Coolant</td>
<td>Water Tank Level</td>
</tr>
<tr>
<td>Batteries</td>
<td>Tires</td>
</tr>
<tr>
<td>All Lights</td>
<td>Air System Pressure</td>
</tr>
<tr>
<td>Horn and Siren</td>
<td>Equipment</td>
</tr>
</tbody>
</table>

Weekly Inspection

<table>
<thead>
<tr>
<th>Transmission Oil Level</th>
<th>Check for Loose Nuts, Pins etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Steering Fluid</td>
<td>Start and Run Motor Driven Equipment</td>
</tr>
<tr>
<td>Hydraulic Brake System</td>
<td>Check Operation of Pump</td>
</tr>
<tr>
<td>Air Brake System</td>
<td>Equipment on Apparatus</td>
</tr>
<tr>
<td>Check All Engine Belts</td>
<td>Ladders</td>
</tr>
<tr>
<td>Battery Terminals / Cables</td>
<td>Tools</td>
</tr>
<tr>
<td>Operate Valves in Cooling System</td>
<td>SCBA</td>
</tr>
<tr>
<td>Check Drainage and Hose Connections</td>
<td>Salvage Equipment</td>
</tr>
</tbody>
</table>
Vacuum Test / Dry Pump Test

- All intakes capped
- All discharges closed and uncapped
- Drain water from pump
- Develop minimum of 22 inches of Hg with primer
- Vacuum should not drop more than 10 inches of Hg in 5 minutes
- Connect hard suction
- Repeat test

Table of Test Procedures for LDH

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Service Test</th>
<th>Proof Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&quot; – 5&quot;</td>
<td>200 psi max</td>
<td>400 psi</td>
</tr>
<tr>
<td>6&quot;</td>
<td>150 psi max</td>
<td>300 psi</td>
</tr>
</tbody>
</table>

*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
Lengths

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

<table>
<thead>
<tr>
<th>Weight and Coil Sizes</th>
<th>4&quot;</th>
<th>5&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coupled Weight 100'</td>
<td>78 pounds</td>
<td>103 pounds</td>
</tr>
<tr>
<td>Cold Size 100'</td>
<td>23 inches</td>
<td>23 inches</td>
</tr>
<tr>
<td>Full of Water</td>
<td>620 pounds</td>
<td>950 pounds</td>
</tr>
</tbody>
</table>

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
- relaying water from pumper to pumper
- directly supplying attack lines, master stream appliances, portable hydrants, manifolds and standpipe and sprinkler systems
**Exception**

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

**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

**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
• 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

• 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

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
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

THERE SHALL BE NO RIDERS ON THE REAR STEP WHILE THE HOSE IS BEING LAID

UNLESS A RIDER IS NECESSARY TO OPERATE THE REEL, IF SO, HE/SHE MUST BE SECURED WITH A SAFETY BELT
Laying Hose from a Hose Bed

- Tie off hose
- Leave plenty of slack
- Lay hose on water supply side of street
- Close to the curb
- Take wide corners
- Cross over in front of the fire

Laying Hose from a Hose Reel

- Hose must be tied off
- Leave plenty of slack
- Lay hose on water supply side of street
- Close to the curb
- Wide corners or "power off" to prevent danger to property or vegetation when the hose pulls around the corner
- Cross over in front of the fire

LDH Hose Clamp

Screw Type Hose Clamp must be used for 4" – 5" – 6" hose

Hebert Hose Clamp
Forward and Reverse Lays

- Depend on department SOP's
- Forward from a pressurized source hydrant
- Reverse to a static source
- Split lay both forward and reverse can be done simultaneously without requiring adapters

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

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
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.

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

Air hammer can destroy a pump

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

Take a full 5 seconds to operate it

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

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

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
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.

Master Stream Appliances

- Master streams are discharged from appliances using 1-1/4" tips or larger.
- 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.

Master Stream Appliances

Portable Unit
Ladder Pipe
Monitor
Deck Gun

Rule of Thumb:
- Start at 25 psi for standpipes.
- Start at 10 psi for master streams and ladder pipes.
- Start at 5 psi for wyes and siameses.
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

See manufacturer’s recommendations regarding limitations

Check manufacturer’s specifications regarding the weight capacity of the aerial
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 outlets
- May also be an outlet that is same size as the inlet

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
Wyes and Siamese Valves

- **Wye**
  - Divides one or more lines
  - Has one female and two or more males
  - Used to divide a larger line into smaller lines or lines of the same size

- **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
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
Strainers

Adapters

<table>
<thead>
<tr>
<th>NPT TO NST / or size</th>
<th>2-1/2&quot; NST to 3&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1/2&quot; NST to 4&quot; Storz</td>
<td>1-1/2&quot; Double Male</td>
</tr>
<tr>
<td>4&quot; x 2&quot; Storz</td>
<td>2-1/2&quot; NST to 5&quot; Storz</td>
</tr>
<tr>
<td>4-1/2&quot; NST Female x 4&quot; Storz</td>
<td>4-1/2&quot; NST Female x 5&quot; Storz</td>
</tr>
<tr>
<td>2-1/2&quot; NST Female x 1-1/2&quot; Male</td>
<td>2-1/2&quot; Double Male</td>
</tr>
<tr>
<td>2-1/2&quot; Plug Cap</td>
<td>2-1/2&quot; Cap</td>
</tr>
<tr>
<td>Suction Caps</td>
<td>Reducer Caps</td>
</tr>
</tbody>
</table>

36
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

<table>
<thead>
<tr>
<th>Friction Loss Rule of Thumb</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4&quot; Hose</strong></td>
</tr>
<tr>
<td>500 gpm</td>
</tr>
<tr>
<td>700 gpm</td>
</tr>
<tr>
<td>1000 gpm</td>
</tr>
<tr>
<td><strong>5&quot; Hose</strong></td>
</tr>
<tr>
<td>1000 gpm</td>
</tr>
<tr>
<td>1500 gpm</td>
</tr>
<tr>
<td>2000 gpm</td>
</tr>
</tbody>
</table>
Joining Couplings

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

Loading LDH

- Communication with driver
- Lighting for nighttime operations
- Force out air and water
- Load downhill
- Roll if possible
- Use a "Lazy Susan" to aid in packing of rolled LDH
Loading a Reel

- Three firefighter operation
  - Driver
  - Reel Operator
  - Load Leveler
- Keep hose tight forcing out air and water (30' back)
- Must be packed tight to avoid droop
- Good lighting for nighttime operation
- Intercom communication with driver

Testing Large Diameter Hose

- Inspect all hose, couplings and joints 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
Advantages of LDH

- Lightweight
- Compact for easy handling and storage
- Non-absorbent; drying is not necessary
- No mildew or rot
- Sexless 1/4 turn couplings
- Couplings attach with great speed and ease
- Reduces the need for multiple 2-1/2” or 3” lines
- Personnel and time requirements are reduced
- Full pump capacity can be supplied
- Cost effective

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

Points to Remember

- When laying line, do not bounce couplings or drag hose
- 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
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

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

Special thanks to:

- Hale Pumps
- Waterous Pumps
- Fire Flow Technologies
- NFPA
For more information, contact:

The Department of Fire Services
Massachusetts Firefighting Academy
PO Box 1035
State Road
Stow, Massachusetts 01775
Phone: 978-567-3200
Fax: 978-567-3229
Website: mass.gov/dfs