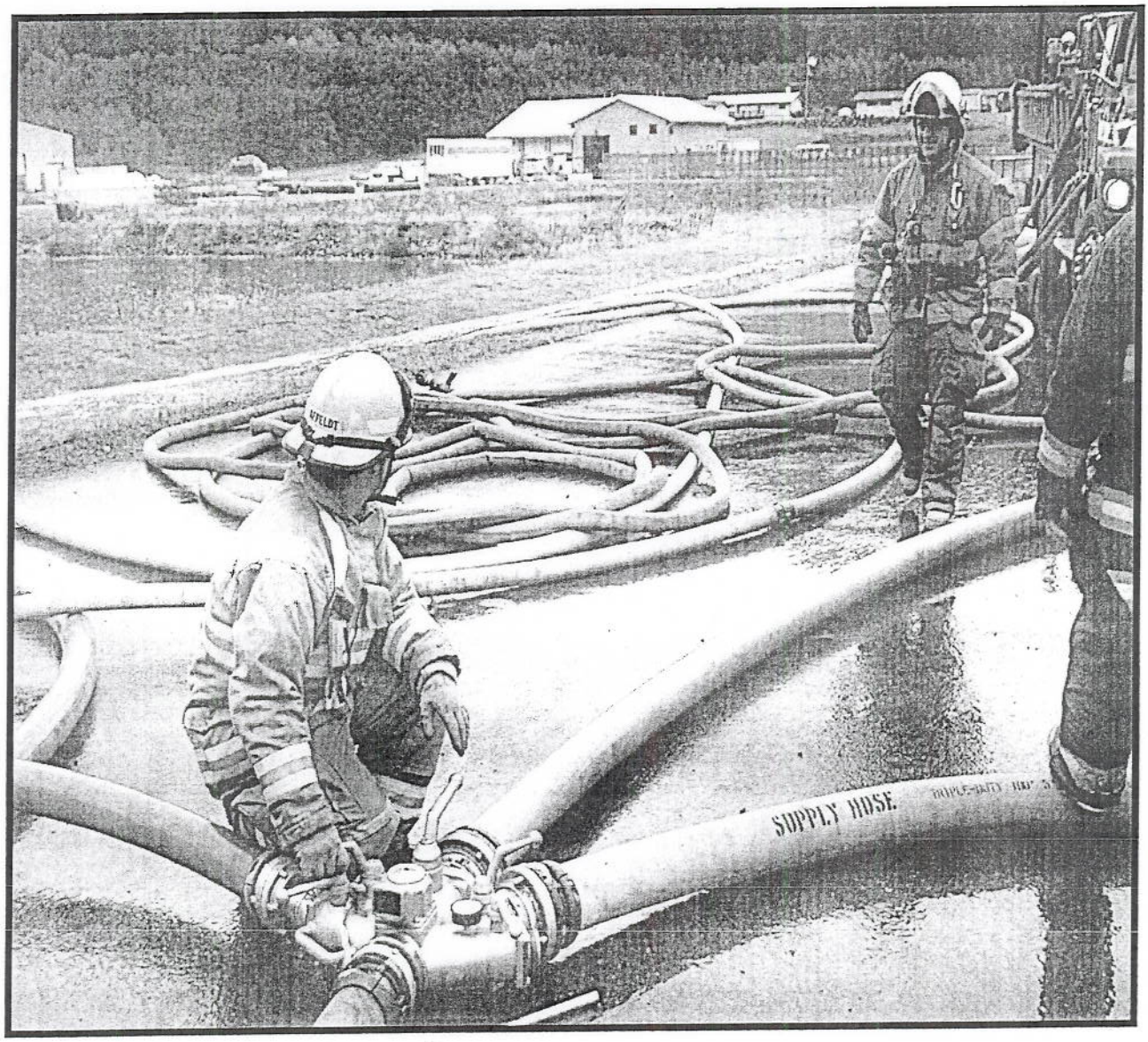
Large Diameter Hose

Student Manual



Department of Fire Services / Massachusetts Firefighting Academy

PO Box 1025 – State Road

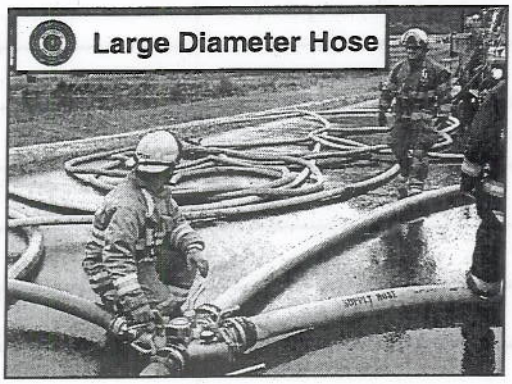
Stow, Massachusetts 01775

978-567-3200

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

Large Diameter Hose 4

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

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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

Large Diameter Hose 6

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

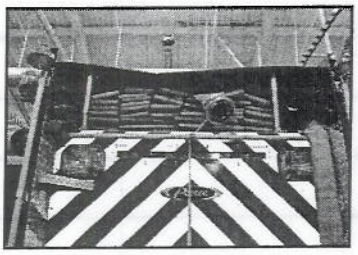
Brief History

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

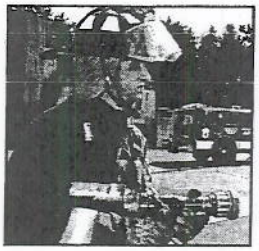
LDH is used for water distribution in the city, rural areas and on limited access highways

Large Diameter Hose 10

Functions of a Fire Dept. Pumper

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

Large Diameter Hose 11

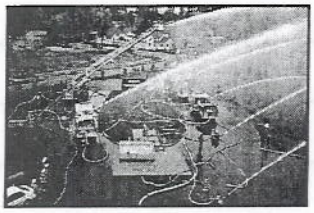


Provides Water for Firefighting

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

Large Diameter Hose 12

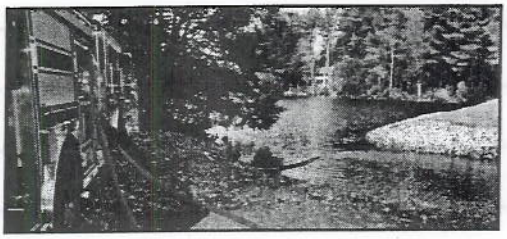
Controls Water



- 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

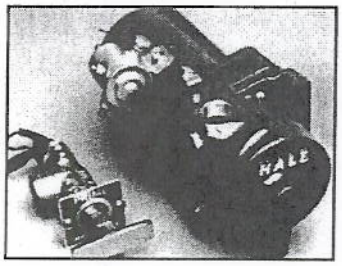


The Need for a Priming Device

- 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

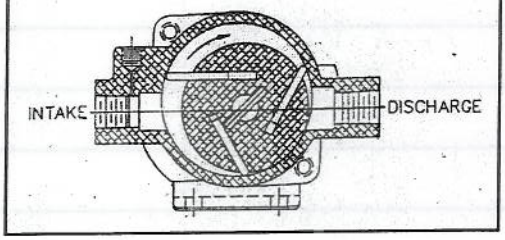


Priming Device

Rotary Vane Pump

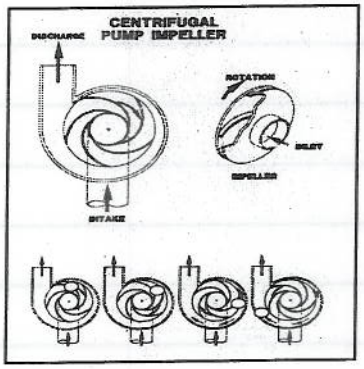
- Used as a priming device
- In a cycle, the rotor turns, and the vanes advance outward
- Space between the rotor and housing is filled with water
- Vanes then force air out the discharge

Rotary Vane Pump



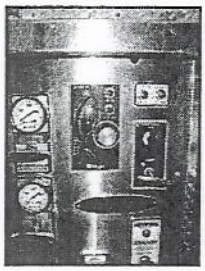
Centrifugal Pump

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



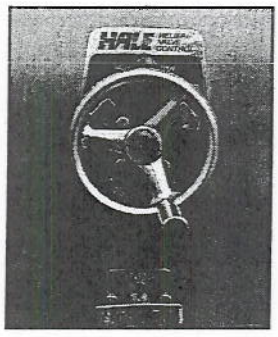
Pressure Relief Devices

- 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



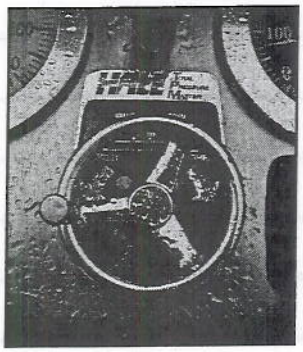
Types of Relief Devices

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



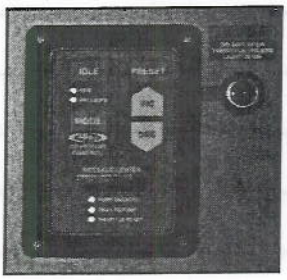
Relief Valve

Controls pressure by rerouting water from the discharge side of the pump



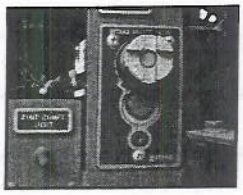
Total Pressure Master

Incoming / Outgoing relief valve made by Hale



Governor

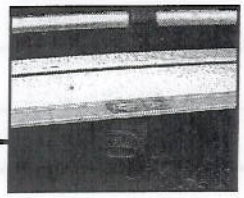
Controls pressure controlling engine speed which in turn affects pump pressure

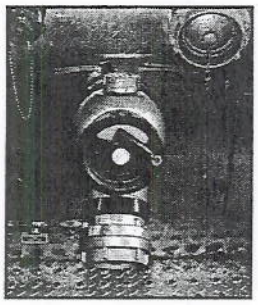


Manufacturer's Built In Relief Valve

Intake Pressure Relief Valve

Do Not Cap

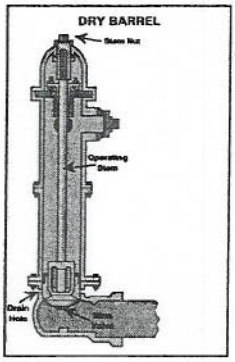




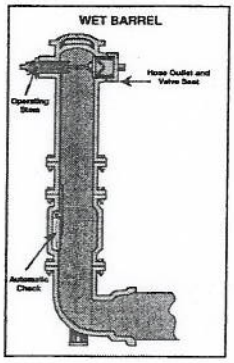
Gated Incoming Relief Valve

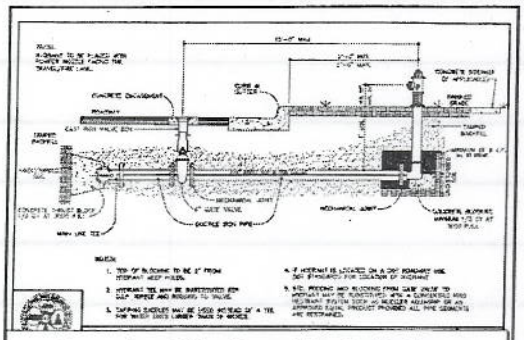
Pressure can be set for incoming LDH lines

ICV's must be adjustable from 90 psi – 185 psi



HYDRANTS





Standard Hydrant Installation

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NFPA Hydrant Color Code

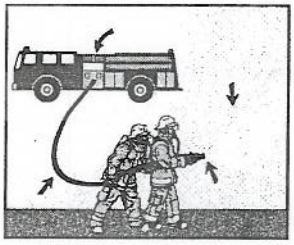
Caps and Bonnet Color Code	
0 – 499 GPM	Red
500 – 999 GPM	Orange
1000 – 1499 GPM	Green
1500 and up	Light Blue

Large Diameter Hose 32

Proper opening of the hydrant requires 18 – 22 turns of the operating nut

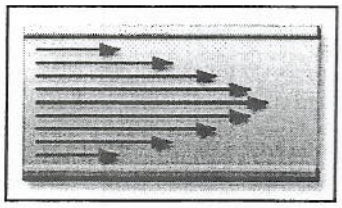
Large Diameter Hose 33

Friction Loss is part of the total pressure that is lost while forcing water through pipes, fittings, fire hose, nozzles and adapters

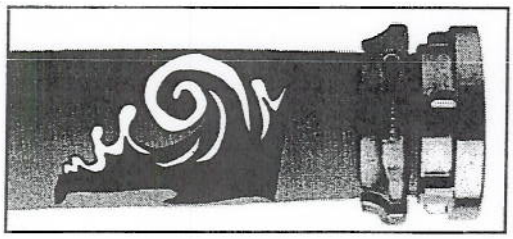


Friction Loss is lost energy!

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

1-1/2"	100 gpm
1-3/4"	150 gpm
2"	200 gpm
2-1/2"	300 gpm
3"	500 gpm
4"	1000 gpm
5"	2000 gpm

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

Large Diameter Hose 40

Normal Operating Pressure:

pressure through water distribution system during normal consumption demands

- Fluctuates during day and night
- And also according to time of year

Large Diameter Hose 41

Line Pressure:

pressure needed to provide proper nozzle pressure with a given layout

Large Diameter Hose 42

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

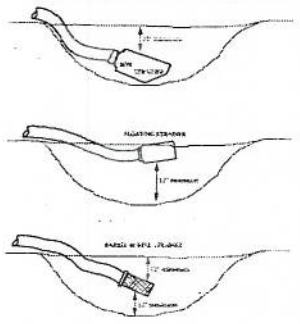
1000 gpm pump – 20' of 5" suction
Net Pressure of 150 psi

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

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

Engine Oil Level	Fuel Level
Radiator Coolant	Water Tank Level
Batteries	Tires
All Lights	Air System Pressure
Horn and Siren	Equipment

Weekly Inspection

Transmission Oil Level	Check for Loose Nuts, Pins etc.
Power Steering Fluid	Start and Run Motor Driven Equipment
Hydraulic Brake System	Check Operation of Pump
Air Brake System	Equipment on Apparatus
Check All Engine Belts	Ladders
Battery Terminals / Cables	Tools
Operate Valves in Cooling System	SCBA
Check Drains and Hose Connections	Salvage Equipment

Vacuum Test / Dry Pump Test

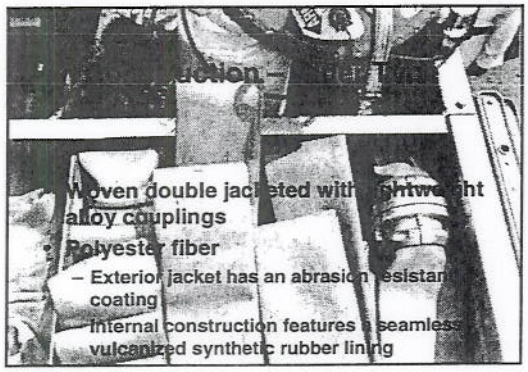
- All intakes capped
- All discharges closed and uncapped
- Drain water from pump
- Develop minimum of 22 inches of Hg with primer
- Vacuum should not drop more than 10 inches of Hg in 5 minutes
- Connect hard suction
- Repeat test

Table of Test Procedures for LDH

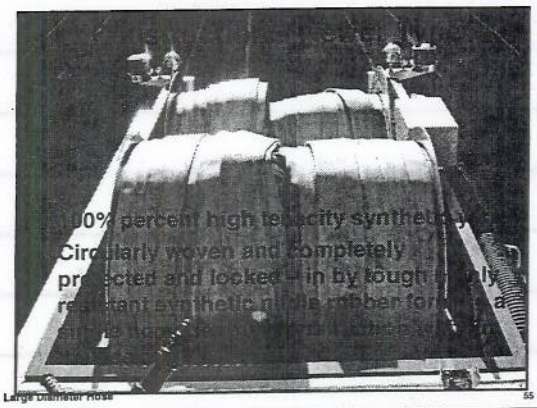
Diameter	Service Test	Proof Test
4" – 5"	200 psi max	400 psi
6"	150 psi max	300 psi

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



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



Large Diameter Hose 55

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

Large Diameter Hose 56

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

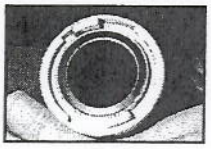
Large Diameter Hose 57

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

Large Diameter Hose 61

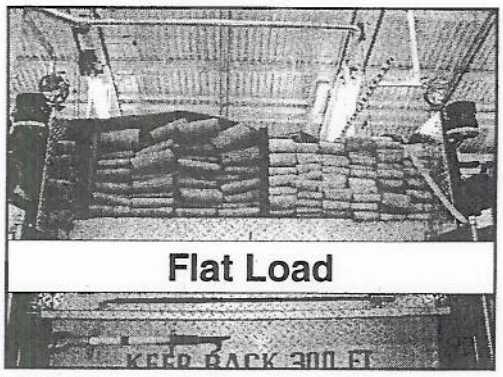
- Most hose is field-repairable
- Couplings can be removed and replaced using allen wrenches
- Splice kits are available from the manufacturer
- All hose should be service tested after any maintenance procedure

Large Diameter Hose 62

Hose Loads

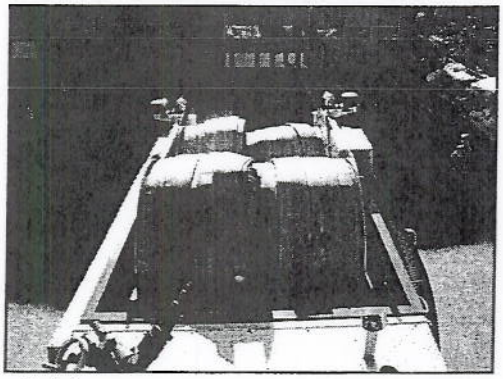
- A conventional hose body should be loaded with the hose laid flat
- Powered reels may be installed on a truck chassis
- A reel truck can lay out one mile of 4" hose in 10 minutes and it can be rewound at approximately 200' per minute

Large Diameter Hose 63



Large Diameter Hose 64

Large Diameter Hose 65



Large Diameter Hose 66

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

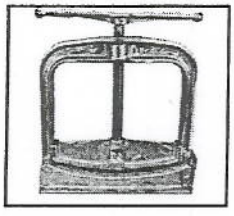
Laying Hose from a Hose Bed

- 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



Hebert Hose Clamp

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

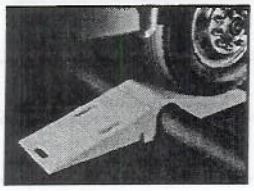
Forward and Reverse Lays

- 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

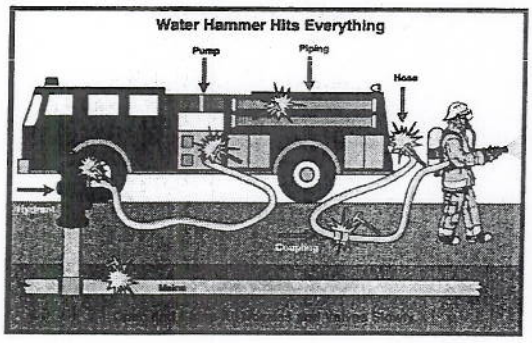
The hose could be pushed in front of the tires and low-slung undercarriages and exhaust systems will cause damage

Large Diameter Hose 76

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

Large Diameter Hose 77



Large Diameter Hose 78

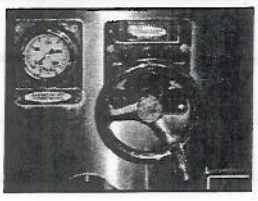
Air Hammer is shock created by the air that precedes water in the line; this compressed air exerts excess pressure on hose appliances, pumps and equipment

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

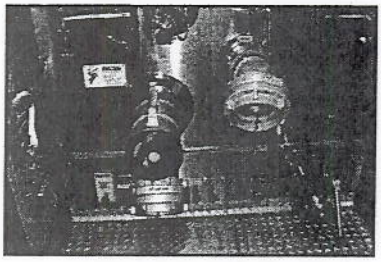


Operation of Large Diameter Hose

- 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

Large Diameter Hose 82

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

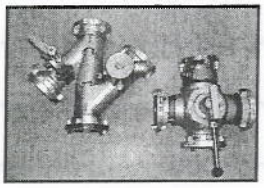


Large Diameter Hose 83

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

Large Diameter Hose 84



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

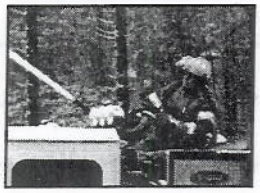
Some departments place a length of colored hose in the hose load so that the relay point can be readily identified

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

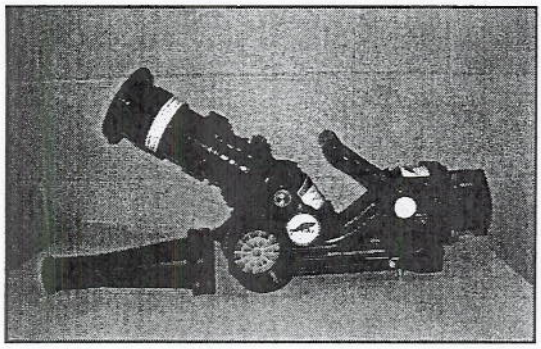


Rule of Thumb:

Start at 25 psi for standpipes

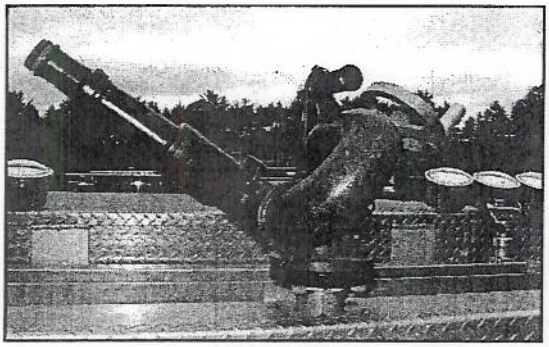
Start at 10 psi for master streams and ladder pipes

Start at 5 psi for wyes and siameses



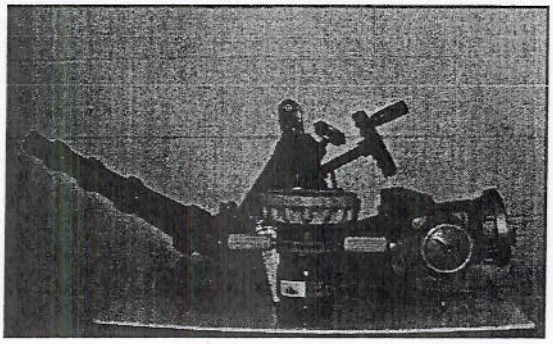
Portable Gun

Large Diameter Hose 88



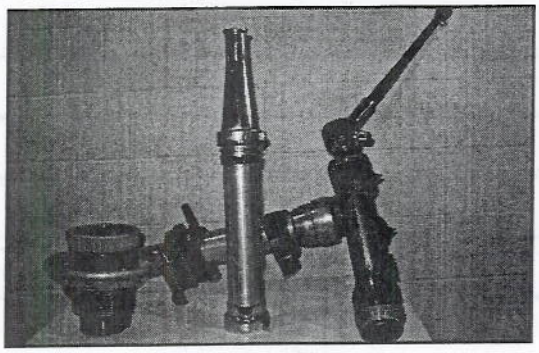
Monitor

Large Diameter Hose 89



Deck Gun

Large Diameter Hose 90



Ladder Pipe

Pressures for Ladder Pipe Operations

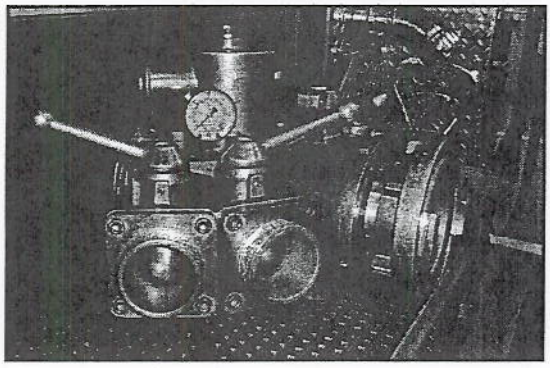
- Nozzle pressure
  - 80 or 100 psi
- Friction loss in gun and siamese
  - 15 psi
- Friction loss in 3" hose
  - Based on size of tip or model of combination nozzle
- Friction loss due to elevation
- Friction loss in supply line

See manufacturer's recommendations regarding limitations

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

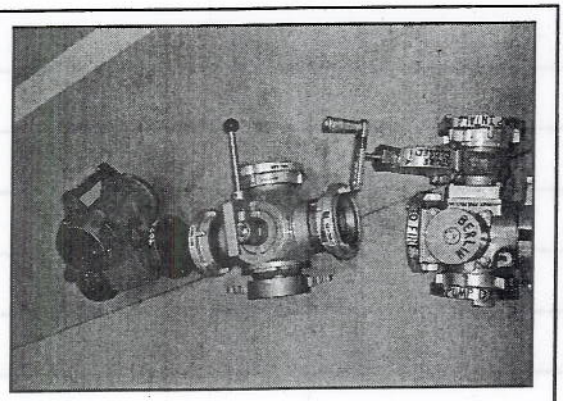
Ball Distributor Valve

- 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



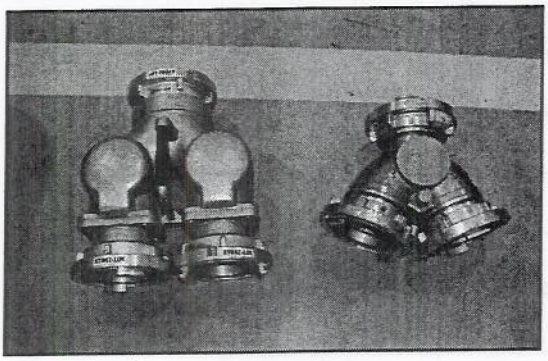
Hydrant Assist Valve

- 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

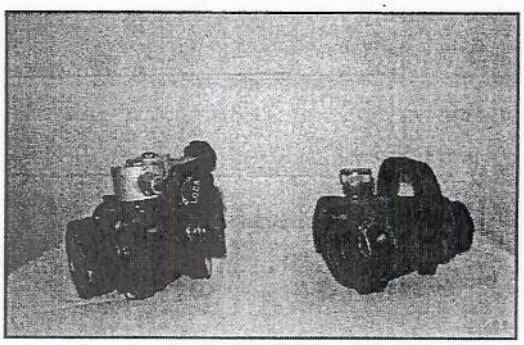


Wyes and Siamese Valves

- 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



LDH Siamese



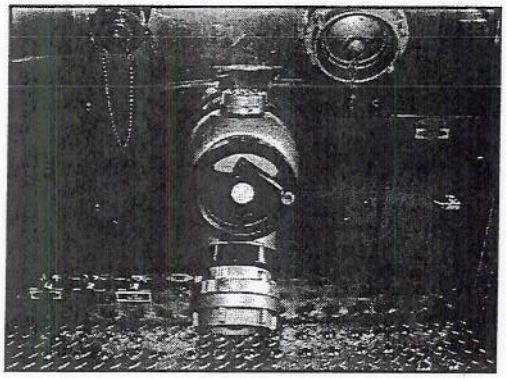
2-1/2" Siamese

Large Diameter Hose 100

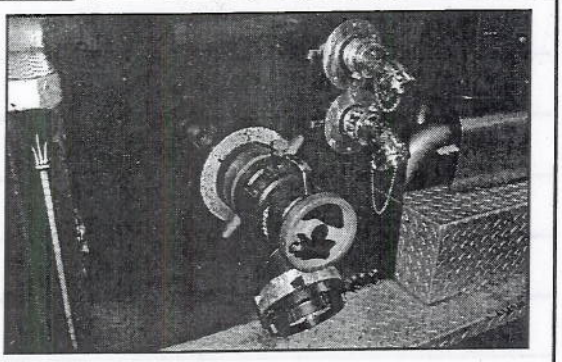
Gated Incoming Relief Valves

- 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

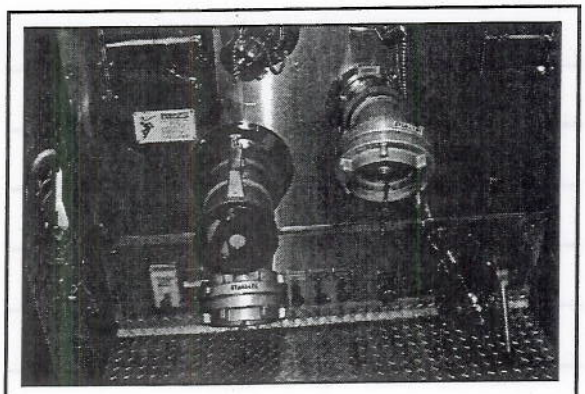
Large Diameter Hose 101



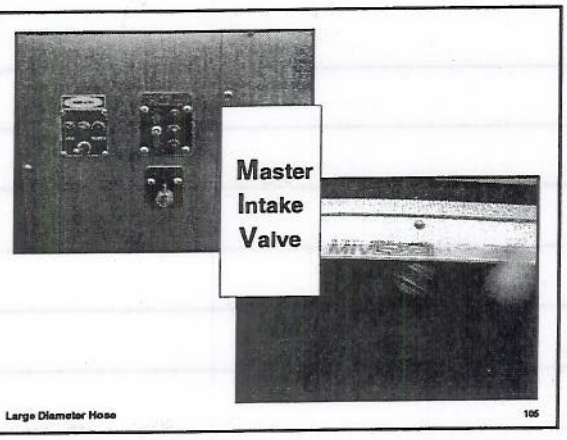
Large Diameter Hose 102



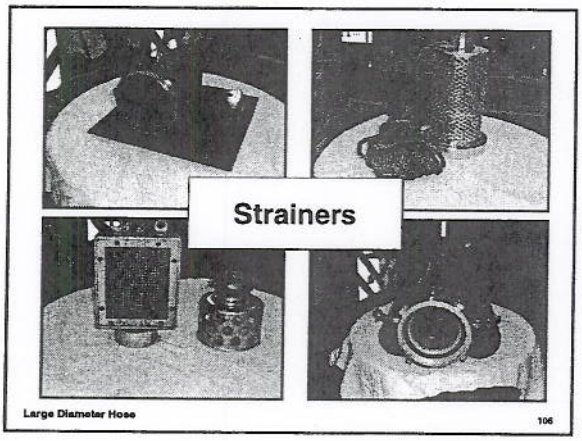
Large Diameter Hose 103



Large Diameter Hose 104



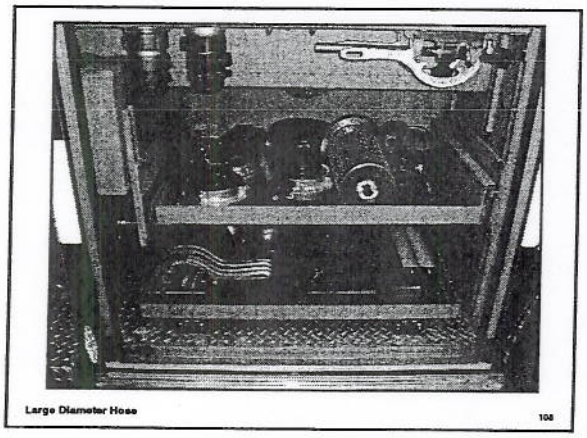
Large Diameter Hose 105

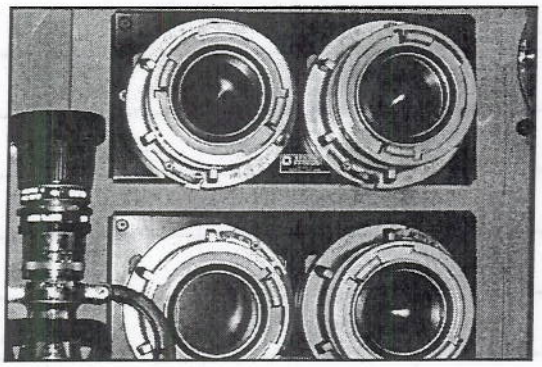


Adapters

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

Large Diameter Hose
107





Large Diameter Hose 109

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

Large Diameter Hose 110

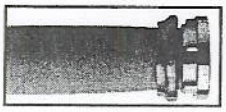
Friction Loss Rule of Thumb

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'

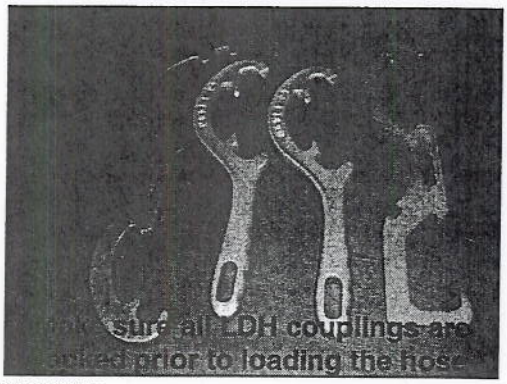
Large Diameter Hose 111

Joining Couplings

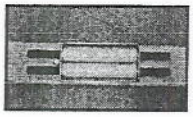
- When joining hoses together, turn couplings until a metallic click is heard
- Hose equipped with locks should have obvious indicators



Large Diameter Hose 112

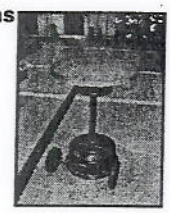


Large Diameter Hose 113



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



Large Diameter Hose 114

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 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

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 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:

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