WALNUT STREET FIRE COMPANY # 4

Basic Hydraulics

Hydraulics - **the mechanics of fluid at rest and in motion**

- **solids and gasses can be compressed**
- **liquids cannot**

LAWS OF SCIENCE RELATING TO WATER

Heat Flow

- **heat is molecular energy**
- **there is no such thing as cold ; cold is the absence of heat**
- **heat flows from hot substances to cold substances**
- **water absorbs heat energy and lowers temperatures to less than that required to sustain combustion**
- **the more water, the more heat is absorbed**
- **volume is the key, not pressure**

Specific Heat - **one pound of water will absorb one BTU while raising the water temperature one degree F**

Latent Heat Vaporization

- **quantity of heat absorbed when water converts from liquid to steam**
- **average water temperature in mains is 65 – 85 degrees F**
- **water turns to steam at 212 degrees F**
- **the difference between 212 degrees and the main temperature is the measure of heat absorbing capability**

Conversion / Expansion

- **when a substance is converted from a liquid to a vapor a volumetric expansion occurs**
- **water converted to steam expands 1700 times its volume and the expansion is instantaneous**

Extinguishment Methods

1. **remove oxygen**
2. **remove heat**
3. **remove fuel**
4. **interrupt chemical chain reaction**

Heat Absorption	-	**water must absorb heat faster than it is being generated by fire**
	-	**volume of water must create heat transfer sufficient to get materials below ignition temperature**

FIRE STREAMS

Solid Stream	-	**compact stream with a minimum amount of detaching particles**
Broken Streams	-	**sometimes called straight stream; provides large, coarse, divided droplets that provide good penetration; less volume than solid streams, but more volume than fog streams**
Fog Streams	-	**small, finely divided droplets of water that absorb heat better than solid or broken streams, convert to steam more rapidly**

SIZES AND VOLUMES OF FIRE STREAMS

Small Streams	-	**low volume streams such as booster lines discharging less than 40 gallons per minute**
Hand Streams	-	**medium volume stream discharging 40 gpm – 350 gpm**
Master Stream	-	**large volume stream discharging 350 – 1500 gpm**

NET PUMP DISCHARGE PRESSURE (PDP)

PDP = FL + NP + AP + EL

FL = friction loss (the smaller the hose, the greater the friction loss)
(the longer the hose, the greater the friction loss)

Hose Size	GPM	Friction Loss Per 100 Ft
1 ¾"	150	56.3 psi
2"	250	41.1 psi
2 ½"	350	26.4 psi
3"	500	21.4 psi
5"	1,000	6.3 psi

NP = nozzle pressure **smooth bore 50 psi** **combination nozzles 100 psi**

master streams 80 psi

AP = appliances (siamese, wyes, etc.) average 10 psi loss

EL = elevation loss average 5 psi per floor

SAMPLE PUMP DISCHARGE PRESSURE CHART

(Always leave 20 psi residual intake pressure for safety)

1 ½" Handline with 100 psi Automatic Nozzle	**100 Ft**	**150 Ft**	**200 Ft**
120 gpm	**110 psi**	**115 psi**	**120 psi**
1 ½" Handline with 150 gpm Smooth Bore	**105 psi**	**130 psi**	**160 psi**

1 ¾" Handline Wih 100 psi Automatic Nozzle	**100 Ft**	**150 Ft**	**200 Ft**
150 gpm	**130 psi**	**145 psi**	**160 psi**
180 gpm	**145 psi**	**170 psi**	**190 psi**

1 ¾" Handline with 100 Smooth Bore Nozzle	**100 Ft**	**150 Ft**	**200 Ft**
180 gpm	**90 psi**	**110 psi**	**130 psi**
210 gpm	**110 psi**	**140 psi**	**170 psi**

2" Handline with 100 PSI Adjustable Nozzle	**100 Ft**	**150 Ft**	**200 Ft**
200 gpm	**130 psi**	**145 psi**	**160 psi**
250 gpm	**150 psi**	**175 psi**	**200 psi**

2" Handline with Smooth Bore Nozzle	**100 Ft**	**150 Ft**	**200 Ft**
210 gpm (1" tip)	**75 psi**	**90 psi**	**100 psi**
250 gpm (1 1/8" tip)	**90 psi**	**110 psi**	**130 psi**

2 ½" Handline with 100 psi Adjustable Nozzle	**100 Ft**	**150 Ft**	**200 Ft**
300 gpm	**120 psi**	**130 psi**	**140 psi**
350 gpm	**125 psi**	**140 psi**	**150 psi**

Ladder Pipe @ 80 psi Nozzle Pressure	**150 psi - 200 psi**