FIREGROUND HYDRAULICS 2022

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OBJECTIVES

- Introduce the basics of fire ground Hydraulics to all participants.
- Ensure proper pump pressure and GPM delivery to hose lines on the fire ground.
- Prepare the student for the Driver Operator (DO) Hydraulics Exam.

INTRODUCTION

- There will be a timed (20 minute), 10 question Final Hydraulics Exam
- The passing score is 80%.
- Each participant must pass this exam in order to continue to Session IV.
- You will have two opportunities to pass the exam.

REFERENCES

- IFSTA Pumping Apparatus Driver/Operator Handbook -Second Edition.
- SDFD Drill Manual, Chapter 13
- Ervens - Fire Fighting Apparatus and Procedures Third Edition

These are the basic concepts that you need to understand.

DETERMINE PUMP PRESSURE

Pump pressure is the amount of pressure in pounds per square inch (PSI) indicated on the pressure gauge or any discharge gauge.

In fire ground hydraulics, the basic pump pressure formula for a level lay is:

Pump **P**ressure = **N**ozzle **P**ressure + **T**otal **F**riction **L**oss

This equation is : **PP = NP + TFL**

FACTS NECESSARY TO DETERMINE PUMP PRESSURE

- NOZZLE PRESSURE
- GPM FLOWING (or SIZE OF THE NOZZLE)
- SIZE OF HOSE
- LENGTH OF HOSE IN LAY
- ELEVATION DIFFERENTIAL
- APPLIANCE LOSS
- SPRINKLER (or STANDPIPE) SYSTEM LOSS
- LADDER SYSTEM LOSS

DETERMINE PUMP PRESSURE

PUMP PRESSURE = NOZZLE PRESSURE + TOTAL FRICTION LOSS

PP = NP + TFL

DETERMINE NOZZLE PRESSURE

POTENTIAL NOZZLE PRESSURES

FOG NOZZLE S.O.F. - HANDLINES

FOG NOZZLE S.O.F. - MASTER STREAMS

ELKHART PHANTOM HIGH RISE NOZZLE

SMOOTH BORE TIPS – HANDLINES

SMOOTH BORE TIPS – MASTER STREAMS

SPINKLER HEAD

DETERMINE NOZZLE PRESSURE

FOG NOZZLE S.O.F. – HANDLINES

100 P.S.I.

DETERMINE NOZZLE PRESSURE

FOG NOZZLE – MASTER STREAMS

100 P.S.I.

Or

80 P.S.I

DETERMINE NOZZLE PRESSURE

ELKHART PHANTOM HIGH RISE NOZZLE

75 P.S.I.

DETERMINE NOZZLE PRESSURE

SMOOTH BORE TIPS – HANDLINES

50 P.S.I.

DETERMINE NOZZLE PRESSURE

SMOOTH BORE TIPS – MASTER STREAMS

80 P.S.I.

DETERMINE NOZZLE PRESSURE

SPRINKLER HEAD

25 P.S.I.

DETERMINE PUMP PRESSURE

PP = NP + TFL

TOTAL FRICTION LOSS

TFL = FLR x L

TOTAL FRICTION LOSS

TOTAL FRICTION LOSS =

FRICTION LOSS RATE x LENGTH

TFL = FLR x L

DETERMINE FRICTION LOSS RATE

$$FLR = 2Q^2$$

BASED ON 2 ½" HOSE

DETERMINE FRICTION LOSS RATE

Q = QUANTITY

$$Q = \frac{GPM}{100}$$

DETERMINE FRICTION LOSS RATE

QUANTITY - EXAMPLE – $2Q^2$

250 G.P.M. S.O.F. FOG NOZZLE

$$Q = \frac{GPM}{100} \qquad Q = \frac{250}{100} \qquad Q = 2.5$$

$2Q^2$ $(2)2.5^2$ $2.5 \times 2.5 = 6.25$ $2 \times 6.25 = 12.5$

FLR = 13

DETERMINE LENGTH

TFL = FLR X L

L = TOTAL LENGTH

100

LENGTH (100') INCREMENTS

100' = 1

50' = .5

DETERMINE LENGTH

EXAMPLE

150’ OF 2 ½” HOSE

$$L = \frac{150}{100}$$

$$L = 1.5$$

DETERMINE TOTAL FRICTION LOSS

TFL = FLR X L

FLR = 13

L= 1.5

TFL = 13 X 1.5

13 X 1.5 = 19.5

TFL = 20

DETERMINE PUMP PRESSURE

PP = NP + TFL

250 G.P.M. S.O.F. FOG NOZZLE - HANDLINE 150' 2 ½" HOSE

NP = 100

TFL = FLR X L

TFL = 13 X 1.5

TFL =19.5 (round to closest)

TFL = 20

PP = 100 + 20

PP = 120 P.S.I.

EQUIVALENT FLOWS

$2Q^2$ BASED ON FLOW THROUGH 2 ½" HOSE

ALL FLOW RATES THROUGH VARIOUS SIZE HOSES MUST BE CONVERTED TO AN EQUIVALENT FLOW (EF) AS IF IT WERE FLOWING THROUGH 2 ½" HOSE

EQUIVALENT FLOWS (EF)

AFTER THE EQUIVALENT FLOW IS COMPUTED, IT IS TREATED AS 2 ½" HOSE. THIS FLOW IS ROUNDED OFF AS 2 ½" HOSE TO THE NEAREST 10 GPM.

EQUIVALENT FLOWS

TO CALCULATE FRICTION LOSS THROUGH HOSE LARGER AND SMALLER THAN 2 ½" HOSE EACH SIZE HOSE HAS A CORRESPONDING CONVERSION FACTOR (CF)

EQUIVALENT FLOWS

HOSE SIZE	CONVERSION FACTOR
¾”	25
1”	9
1 ½”	3.6
1 ¾”	2
3”	.67
3 ½”	.4
4”	.25

EQUIVALENT FLOWS

EXAMPLE:

1 ¾" HANDLINE 150 G.P.M. S.O.F. FOG NOZZLE

1 ¾" HOSE – CONVERSION FACTOR OF 2

150 G.P.M. X 2 = (EF) 300 G.P.M

$$2Q^2 \quad Q = \frac{300}{100}$$

EQUIVALENT FLOWS

EXAMPLE:

1000 G.P.M. FOG NOZZLE MASTER STREAM SUPPLIED BY 4" LINE

1000 G.P.M. – 4" CONVERSION FACTOR .25

1000 X .25 = (EF) 250 GPM

$$2Q^2 \qquad Q = \frac{250}{100}$$

G.P.M. FLOWS

FOG NOZZLES

SMOOTH BORE TIPS

SPRINKLER HEADS

GPM FLOWS FOR FOG NOZZLES

Handheld Fog Nozzles:

GPM FLOWS ARE ADJUSTABLE AND FOUND LABELED ON THE NOZZLE.

GPM FLOWS FOR FOG NOZZLES

Master Stream Fog Nozzles:

Are not adjustable they are Automatic with GPM Labeled on the nozzle

GPM FLOWS FOR FOG NOZZLES

When pumping to a hose line used for an **INTERIOR ATTACK** and the GPM setting is not known, you should consider **150 GPM** as your maximum GPM flow.

When pumping to a hose line used for an **EXTERIOR ATTACK** and the GPM is not known, you should consider **200 GPM** as your maximum GPM flow.

When the GPM settings and the use of the attack line are BOTH **UNKNOWN**, you should pump to the **HIGHEST GPM** setting for that nozzle.

G.P.M. FLOWS

SPRINKLER HEAD

30 G.P.M.

GPM SMOOTH BORE TIP

SMOOTH BORE TIP FORMULA

$$GPM = 30\ d^2\ \sqrt{NP}$$

GPM FLOWS FOR SMOOTH BORE TIPS

$$GPM = 30\ d^2\ \sqrt{NP}$$

d = DIAMETER

NP = NOZZLE PRESSURE

ONLY TWO SQUARE ROOTS ARE USED

$\sqrt{50}$ PSI (HANDLINE SMOOTH TIP) = 7

$\sqrt{80}$ PSI (MONITOR/MASTER STREAM) = 9

GPM FLOWS FOR SMOOTH BORE TIPS

- **THE DIAMETER OF THE TIP AND THE NOZZLE PRESSURE DETERMINE GPM FLOW.**

1 1/4" TIP @ 50 PSI = 330 GPM
1 1/4" TIP @ 80 PSI = 400 GPM

GPM FLOWS FOR SMOOTH BORE TIPS

$$GPM = 30\ d^2\ \sqrt{NP}$$

ROUND OFF ACCORDING TO THE FOLLOWING RULES:

1/4” TO 3/8” TIPS - NEAREST 1 GPM

1/2” TO 1 1/4” TIPS - NEAREST 10 GPM

1 3/8” TO 2” TIPS - NEAREST 100 GPM

GPM FLOWS FOR SMOOTH BORE TIPS

EXAMPLE:
3/8” SMOOTH BORE TIP

$$GPM = 30\ d^2\ \sqrt{NP}$$

$$GPM = (30)\ 3/8^2\ (7)$$

$$GPM = (30)\ .375\ X.375\ (7)$$

$$GPM = (30)\ .1406\ (7)$$

$$GPM = 4.218\ (7)$$

$$GPM = 29.52$$

ROUNDED 29.52 = 30

GPM FLOWS FOR SMOOTH BORE TIPS

EXAMPLE:

1 1/8" SMOOTH BORE TIP HANDLINE

$$GPM = 30\ d^2\sqrt{NP}$$

$$GPM = (30)\ 1.125\ X\ 1.125\ (7)$$

$$GPM = (30)\ 1.266\ (7)$$

$$GPM = 37.98\ (7)$$

$$GPM = 265.86$$

(ROUNDED TO NEAREST 10 GPM) = 270 GPM

GPM FLOWS FOR SMOOTH BORE TIPS

EXAMPLE

1 ½" SMOOTH BORE TIP LADDER PIPE

GPM = 30 $d^2\sqrt{NP}$

GPM = (30) 1.5 X 1.5 (9)

GPM = (30) 2.25 (9)

GPM = 67.5 (9)

GPM = 607.5

607.5(ROUNDED TO NEAREST 100 GPM) = 600 GPM

MAXIMUM PUMP PRESSURES

BOOSTER LINE – 400 PSI

SINGLE JACKET (Wildland) – 300 PSI

DOUBLE JACKET (Attack Line) – 300 PSI

DOUBLE JACKET (High Pressure) – 600 PSI

HARD SUCTION – 150 PSI

ELEVATION DIFFERENTIAL BETWEEN PUMP AND NOZZLE

WATER WEIGHS 8.35 POUNDS PER GALLON

A COLUMN OF WATER THAT IS ONE FOOT HIGH BY ONE SQUARE INCH WEIGHS .434 POUNDS.

FOR FIRE GROUND HYDRAULICS, THIS WEIGHT HAS BEEN ROUNDED OFF TO .5 POUNDS.

ELEVATION DIFFERENTIAL BETWEEN PUMP AND NOZZLE

WHEN CALCULATING GRAVITY LOSS IN A HIGH-RISE BUILDING, CALCULATE 5 POUNDS PER FLOOR.

REMEMBER

GRAVITY **L**OSS (**GL**) = **ADD PRESSURE**

GRAVITY **G**AIN (**GG**) = **SUBTRACT PRESSURE**

ELEVATION DIFFERENTIAL BETWEEN PUMP AND NOZZLE

EXAMPLE:

250 G.P.M. S.O.F. FOG NOZZLE – HANDLINE 150' 2 ½" HOSE

PP = 120 P.S.I.

250 G.P.M. S.O.F. FOG NOZZLE – HANDLINE 150' 2 ½" HOSE

3RD FLOOR

5 POUNDS PER FLOOR

PP = 130 P.S.I.

INITIAL PUMP PRESSURE

OFTEN, AN ENGINEER WILL GET THE REQUEST FOR WATER BEFORE ACCURATE HYDRAULIC CALCULATIONS CAN BE MADE. IN THIS SITUATION, THE STANDARD OPERATING PROCEDURE IS TO PUMP THE PRESSURES GIVEN BELOW FOR THE FOLLOWING CASES:

INITIAL PUMP PRESSURE

HAND LINES:

NOZZLE PRESSURE + GL or - GG

ELEVATED STREAMS

150 P.S.I.

SPRINKLER and STANDPIPE SYSTEMS

150 P.S.I.

HYDRAULICS SET-UP AND CALCULATIONS

THE FOLLOWING EXAMPLES SHOW HOW FIREGROUND HYDRAULICS IS EXPRESSED IN WRITTEN HYDRAULICS

HYDRAULICS SET-UP AND CALCULATIONS

250 GPM S.O.F. NOZZLE, 150’ 2 ½’ HOSE

PP = ?

250 GPM S.O.F. NOZZLE

150’ 2 ½’ HOSE

INITIAL PUMP PRESSURE = 100 P.S.I.

HYDRAULICS SET-UP AND CALCULATIONS

HYDRAULICS FORMULA FOR A LEVEL LAY

$$PP = NP + TFL$$

$$TFL = FLR \times L$$

$$FLR = 2Q^2$$

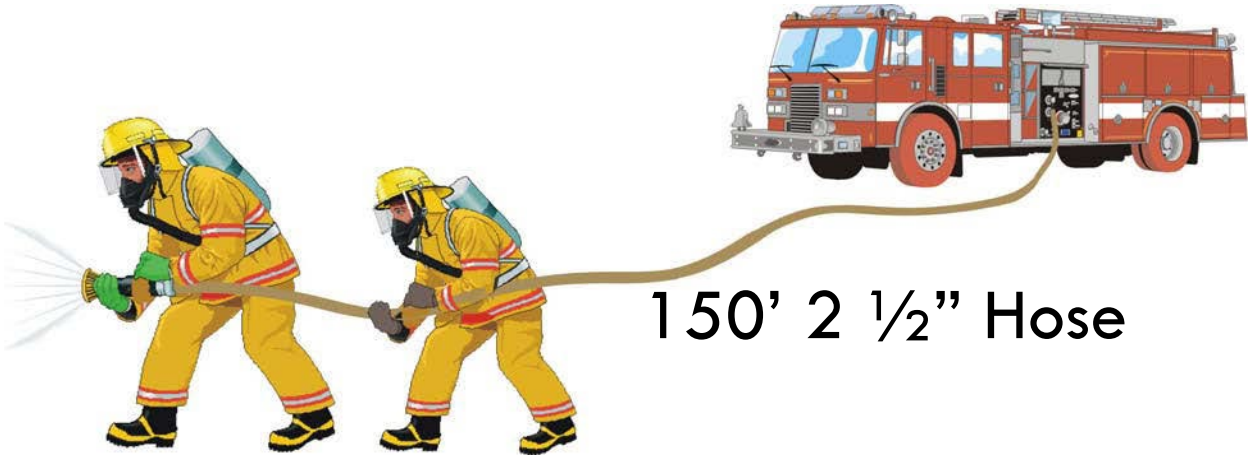
$$Q = \frac{GPM}{100}$$

HYDRAULICS SET-UP AND CALCULATIONS

STEP ONE:

DETERMINE NOZZLE PRESSURE

NP=100

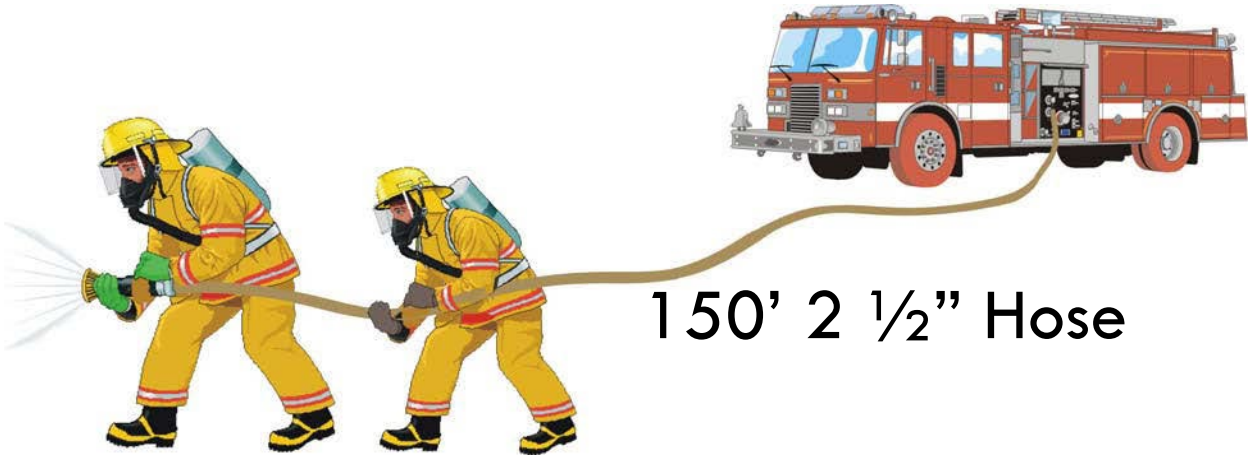


HYDRAULICS SET-UP AND CALCULATIONS

STEP TWO:

DETERMINE GPM FLOW

250 GPM



HYDRAULICS SET-UP AND CALCULATIONS

STEP THREE:

CALCULATE THE FRICTION LOSS RATE (FLR)

HYDRAULICS SET-UP AND CALCULATIONS

$FLR = 2Q^2$

$FLR = 2(\frac{250}{100})^2$

$FLR = 2(2.5)^2$

$FLR = 2(2.5 \times 2.5)$

$FLR = 2(6.25)$

$FLR = 12.5$

$FLR = 13$

RULE OF TWELVE

FOR 2 ½" FLOWS BETWEEN 180 AND 320 SUBTRACT 12 FROM THE FIRST TWO NUMBERS

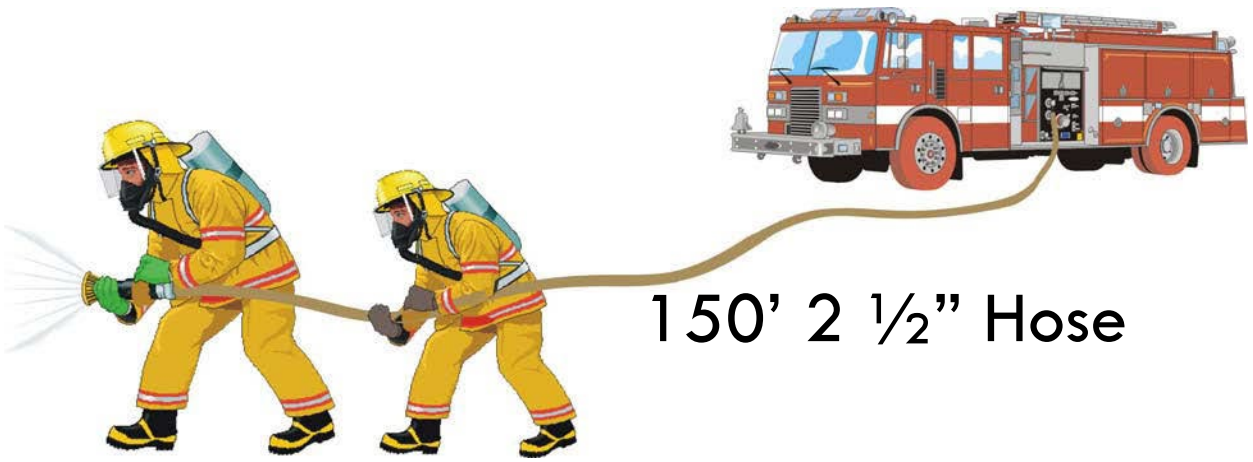
250 GPM

250 – 12 = 13

HYDRAULICS SET-UP AND CALCULATIONS

STEP FOUR:
DETERMINE LENGTH

$$L = \frac{\text{TOTAL FEET}}{100} \qquad L = \frac{150}{100} \qquad L = 1.5$$



HYDRAULICS SET-UP AND CALCULATIONS

STEP FIVE:

CALCULATE TOTAL FRICTION LOSS (TFL)

TFL = FLR X L

TFL = 13 X 1.5

TFL = 19.5 ROUND UP

TFL = 20

HYDRAULICS SET-UP AND CALCULATIONS

STEP SIX:

DETERMINE PUMP PRESSURE

ADD NOZZLE PRESSURE (NP) AND TOTAL FRICTION LOSS (TFL)

PP = NP + TFL

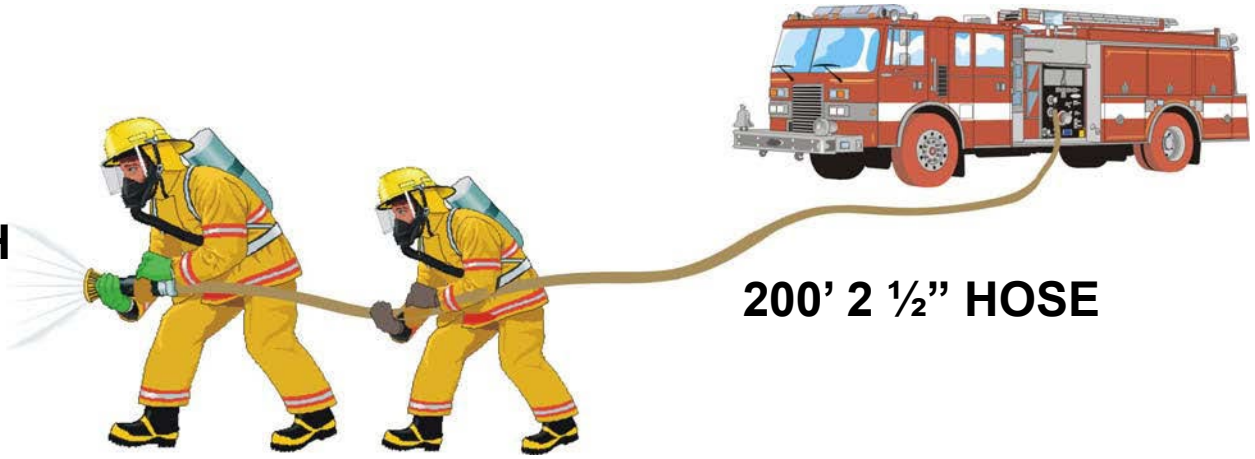
PP = 100 + 20

PP = 120 P.S.I.

HYDRAULICS SET-UP AND CALCULATIONS

SMOOTH BORE TIP:

PP = NP + TFL



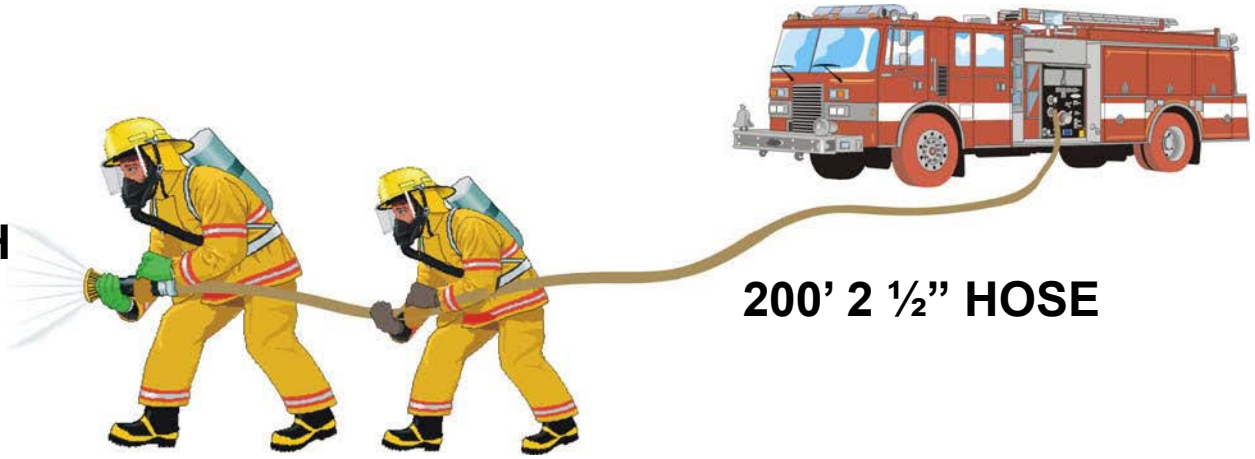
INITIAL PUMP PRESSURE = 50 P.S.I.

HYDRAULICS SET-UP AND CALCULATIONS

STEP ONE:

DETERMINE NOZZLE PRESSURE

NP= 50



1” SMOOTH BORE TIP

200’ 2 ½” HOSE

INITIAL PUMP PRESSURE = 50 P.S.I.

HYDRAULICS SET-UP AND CALCULATIONS

STEP TWO:

DETERMINE GPM FLOW

$$GPM = 30\ d^2\ \sqrt{NP}$$

HYDRAULICS SET-UP AND CALCULATIONS

$$GPM = 30\ d^2 \sqrt{NP}$$

1” SMOOTH BORE TIP

$$30\ (1)^2 \sqrt{50}$$

30 X 1 X 7

GPM = 210

HYDRAULICS SET-UP AND CALCULATIONS

STEP THREE:

CALCULATE THE FRICTION LOSS RATE (FLR)

$$FLR = 2Q^2$$

HYDRAULICS SET-UP AND CALCULATIONS

$FLR = 2Q^2$

$FLR = 2(\frac{210}{100})^2$

$FLR = 2(2.1)^2$

$FLR = 2(2.1 \times 2.1)$

$FLR = 2(4.41)$

$FLR = 8.82$

$FLR = 9$

RULE OF TWELVE

FOR 2 ½" FLOWS BETWEEN 180 AND 320 SUBTRACT 12 FROM THE FIRST TWO NUMBERS

210 GPM

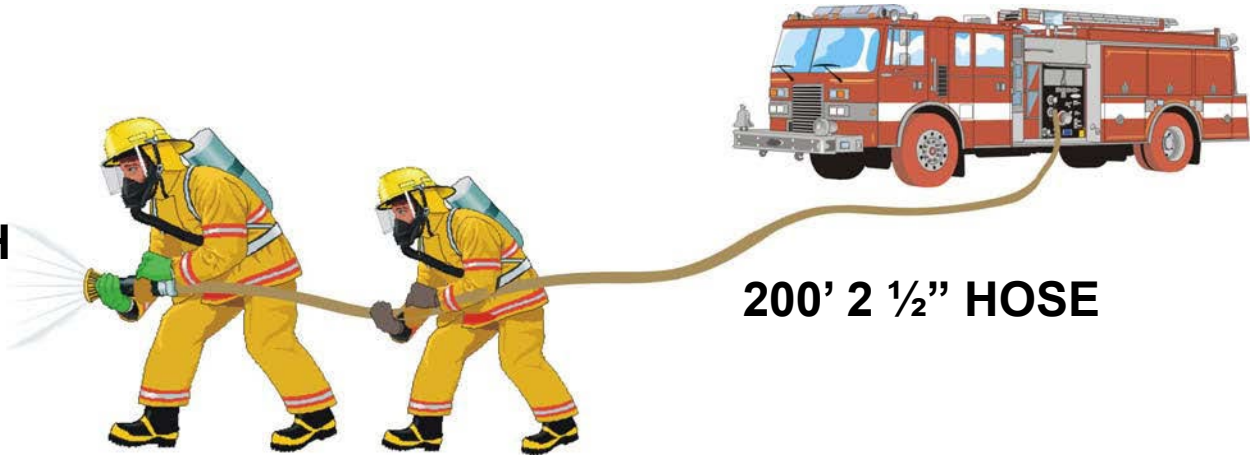
210 – 12 = 9

HYDRAULICS SET-UP AND CALCULATIONS

STEP FOUR:

DETERMINE LENGTH

$$L = \frac{\text{TOTAL FEET}}{100} \qquad L = \frac{200}{100} \qquad L = 2$$



1” SMOOTH BORE TIP

200’ 2 ½” HOSE

INITIAL PUMP PRESSURE = 50 P.S.I.

HYDRAULICS SET-UP AND CALCULATIONS

STEP FIVE:

CALCULATE TOTAL FRICTION LOSS (TFL)

TFL = FLR X L

TFL = 9 X 2

TFL = 18

HYDRAULICS SET-UP AND CALCULATIONS

STEP SIX:

DETERMINE PUMP PRESSURE

ADD NOZZLE PRESSURE (NP) AND TOTAL FRICTION LOSS (TFL)

PP = NP + TFL

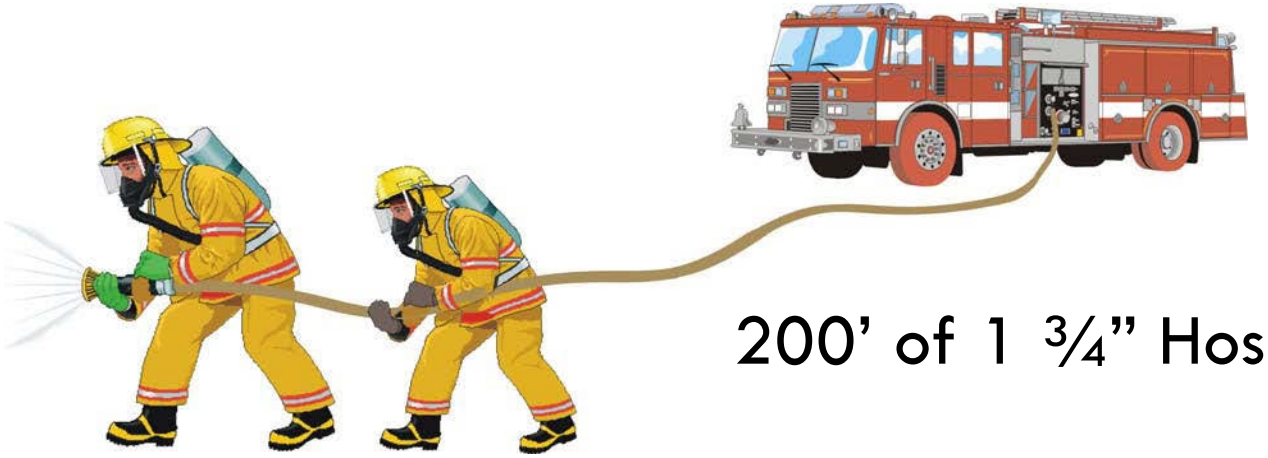
PP = 50 + 18

PP = 68 P.S.I.

CONVERTING TO 2 ½" HOSE

Step one:
Determine Flow = 125 GPM
EF = Conversion Factor x GPM
CF for 1 ¾" hose = 2
EF = 2 x 125
EF = 250

125 GPM
S.O.F.
NOZZLE



200' of 1 ¾" Hose

CONVERTING TO 2 ½" HOSE

Step Two:

$$FLR = 2Q^2$$

$$FLR = 2\left(\frac{gpm}{100}\right)^2$$

$$FLR = 2\left(\frac{250}{100}\right)^2 = 2.5$$

$$FLR = 2\,(2.5)^2$$

$$FLR = 2 \times 6.25 = 12.5$$

Round off to 13 PSI

125 GPM
S.O.F.
NOZZLE

200' of 1 ¾" Hose

CONVERTING TO 2 ½" HOSE

Step Three:

$$L = \frac{\text{Total Feet}}{100}$$

$$L = \frac{200}{100}$$

$$L = 2$$

125 GPM
S.O.F.
NOZZLE

200' of 1 ¾" Hose

CONVERTING TO 2 ½" HOSE

Step Four:

TFL = FLR X L

TFL = 13 X 2

TFL = 26 PSI

PP = NP + TFL

PP = 100 + 26

PP = 126 PSI

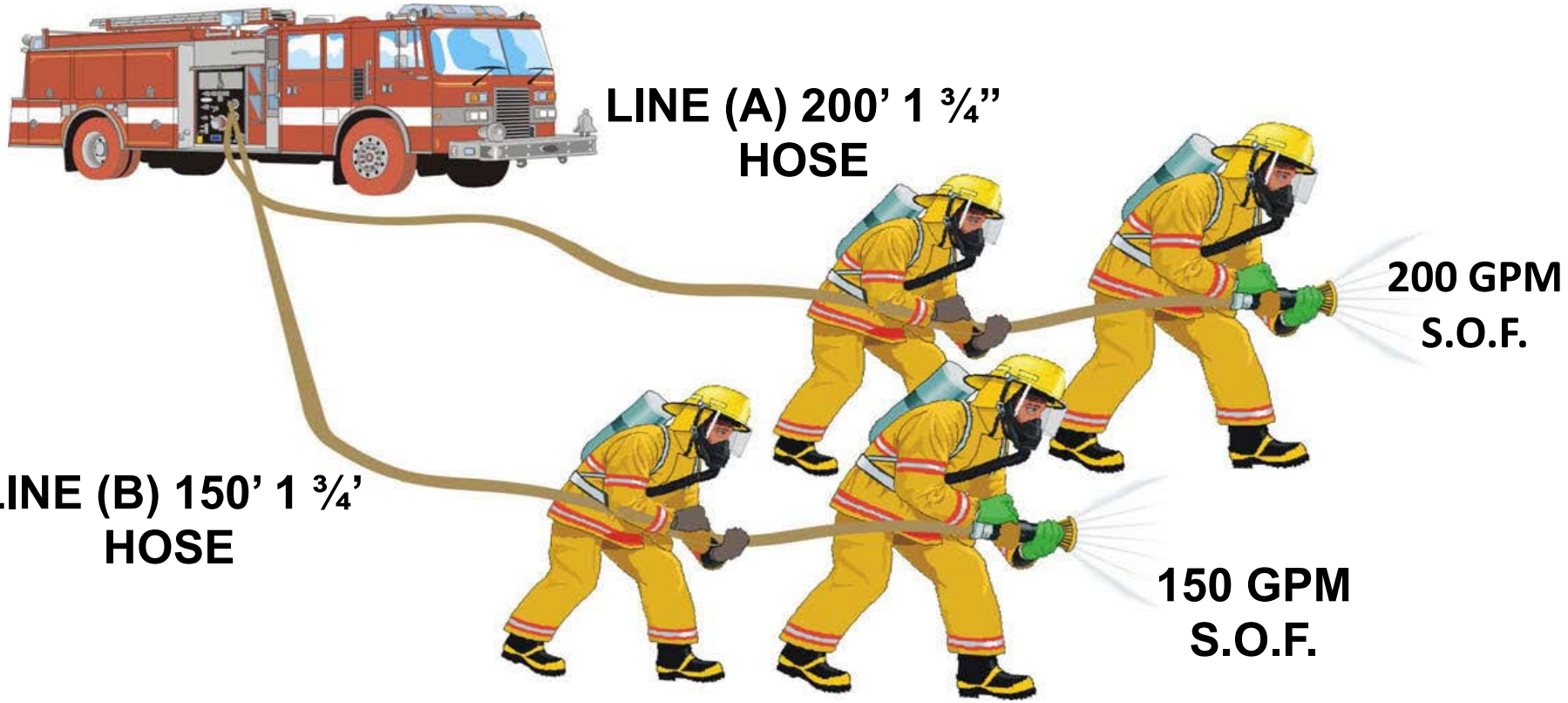
125 GPM
S.O.F.
NOZZLE

200' of 1 ¾" Hose

MULTIPLE LINES

PUMP TO THE HIGHEST LINE AND GATE DOWN THE SECOND

MULTIPLE LINES



MULTIPLE LINES

LINE (A)

PP = NP = TFL

NP = 100

INITIAL PP = 100

LINE (B)

PP = NP = TFL

NP = 100

INITIAL PP = 100

MULTIPLE LINES

STEP TWO:

1 ¾” HOSE REQUIRES CONVERSION TO DETERMINE EQUIVILANT FLOW (EF)

MULTIPLE LINES

LINE (A)

(EF) = CONVERSION FACTOR X GPM

FLOW = 200 GPM

1 ¾" CF = 2

200 X 2 = 400

EF = 400

LINE (B)

(EF) = CONVERSION FACTOR X GPM

FLOW = 150 GPM

1 ¾" CF = 2

150 X 2 = 300

EF = 300

MULTIPLE LINES

STEP THREE:
DETERMINE FRICTION LOSS RATE (FLR)

MULTIPLE LINES

LINE (A)

$FLR = 2Q^2$

$FLR = 2\left(\frac{400}{100}\right)^2$

$FLR = 2(4)^2$

$FLR = 2(4 \times 4)$

$FLR = 2(16)$

$FLR = 32$

LINE (B)

$FLR = 2Q^2$

$FLR = 2\left(\frac{300}{100}\right)^2$

$FLR = 2(3)^2$

$FLR = 2(3 \times 3)$

$FLR = 2(9)$

$FLR = 18$

MULTIPLE LINES

STEP FOUR:

DETERMINE LENGTH

$$L = \frac{\text{TOTAL FEET}}{100}$$

MULTIPLE LINES

DETERMINE LENGTH

LINE (A)

$$L = \frac{200}{100}$$

$$L = 2$$

DETERMINE LENGTH

LINE (B)

$$L = \frac{150}{100}$$

$$L = 1.5$$

MULTIPLE LINES

STEP FIVE:

CALCULATE TOTAL FRICTION LOSS (TFL)

MULTIPLE LINES

TOTAL FRICTION LOSS

LINE (A)

TFL = FLR X L

TFL = 32 X 2

TFL = 64

TOTAL FRICTION LOSS

LINE (B)

TFL = FLR X L

TFL = 18 X 1.5

TFL = 27

MULTIPLE LINES

STEP SIX:

DETERMINE PUMP PRESSURE

ADD NOZZLE PRESSURE (NP) AND TOTAL FRICTION LOSS (TFL)

MULTIPLE LINES

DETERMINE PUMP PRESSURE

LINE (A)

PP = NP + TFL

PP = 100 + 64

PP = 164

PUMP LINE (A) AT 164 P.S.I.

DETERMINE PUMP PRESSURE

LINE (B)

PP = NP + TFL

PP = 100 + 27

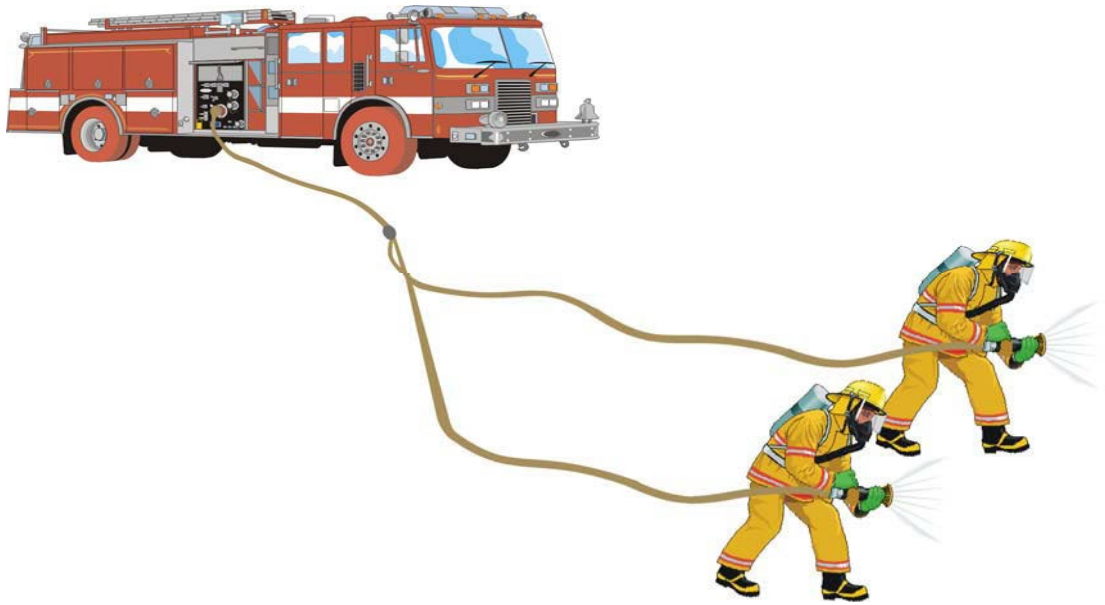
PP = 127

GATE DOWN LINE (B) TO 127 P.S.I.

WYED LINES (EQUAL LENGTH AND FLOW)

EXAMPLE:

(2) 250 GPM S.O.F. NOZZLES, (2) 2 ½" HOSE LINES EACH 100' LONG, WYED FROM (1) 2 ½" HOSE 200' LONG.



WYED LINES (EQUAL LENGTH AND FLOW)

200’ 2 ½” HOSE

Line (A)100’ 2 ½” HOSE

Line (B)100’ 2 ½” HOSE

250 GPM S.O.F. NOZZLE

250 GPM S.O.F. NOZZLE

WYED LINES
(EQUAL LENGTH AND FLOW)

STEP ONE:

DETERMINE NOZZLE PRESSURE

NP = 100 P.S.I.

WYED LINES (EQUAL LENGTH AND FLOW)

STEP TWO:

DETERMINE FLOW

TO DETERMINE FLOW IN SUPPLY LINE COMBINE NOZZLE FLOWS

FLOW THROUGH LINE (A) = 500

FLOW THROUGH ONE WYED LINE = 250

WYED LINES (EQUAL LENGTH AND FLOW)

STEP THREE:

DETERMINE FRICTION LOSS RATE (FLR)

$$FLR = 2Q^2$$

WYED LINES (EQUAL LENGTH AND FLOW)

LINE (A)

$FLR = 2Q^2$

$FLR = 2\left(\frac{500}{100}\right)^2$

$FLR = 2(5 \times 5)$

$FLR = 2(25)$

$FLR = 50$

LINE (B)

$FLR = 2Q^2$

$FLR = 2(250)^2$

$FLR = 2(2.5 \times 2.5)$

$FLR = 2(6.25)$

$FLR = 13$

WYED LINES (EQUAL LENGTH AND FLOW)

STEP FOUR:

DETERMINE LENGTH

$$L = \frac{\text{TOTAL FEET}}{100}$$

LINE (A)

$$200'' = \frac{200}{100}$$

LINE (A) = 2

LINE (B)

$$100'' = \frac{100}{100}$$

LINE (B) = 1

WYED LINES (EQUAL LENGTH AND FLOW)

STEP FIVE:

DETERMINE TOTAL FRICTION LOSS (TFL)

TFL = FLR (A) X L (A) +FLR (B) X L (B)

WYED LINES (EQUAL LENGTH AND FLOW)

TFL = FLR (A) X L (A) +FLR (B) X L (B)

LINE (A)	LINE (B)
FLR 50 X 2	FLR 13 X 1
50 X 2	13 X 1
100	13

TFL = 100 + 13

TFL = 113

WYED LINES (EQUAL LENGTH AND FLOW)

STEP SIX:

DETERMINE PUMP PRESSURE

PP = NP + TFL

PP = 100 + 113

PP = 213

WYED LINES

CALCULATION POSSIBLITIES:

- EQUAL LENGTH AND FLOW
- EQUAL LENGTH DIFFERENT GPM FLOW
- DIFFERENT LENGTH EQUAL GPM FLOW
- DIFFERENT LENGTH AND FLOW
- ELEVATION CHANGES BETWEEN LINES
- DIFFERENT HOSE SIZES

SIAMESE LINES (EQUAL LENGTH)

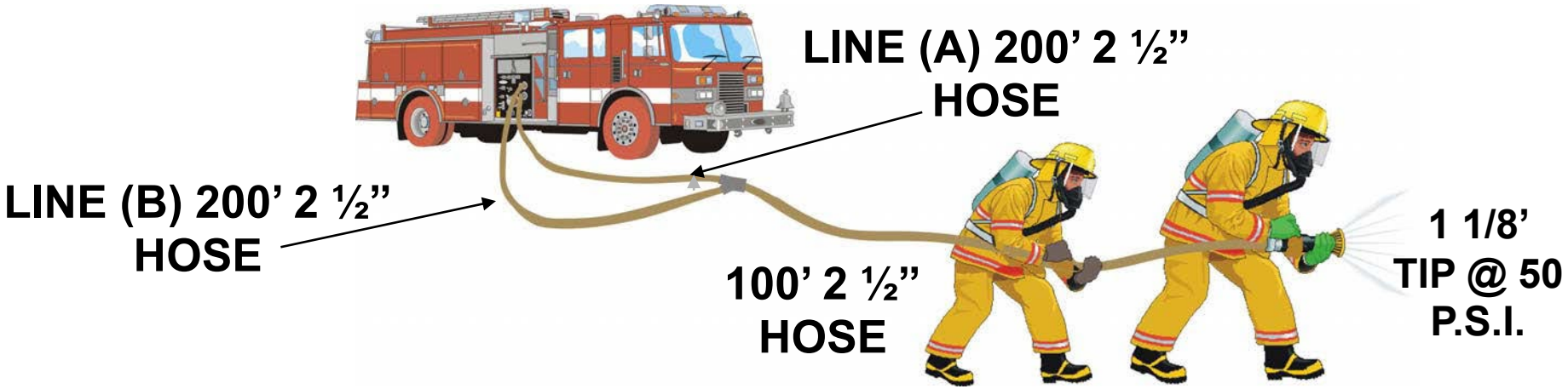
FOR EQUAL LENGTH DIVIDE FLOW AND CALCULATE FOR ONE LINE

SIAMESE LINES (EQUAL LENGTH)

EXAMPLE:

1 1/8” TIP, 50 P.S.I., (2) 200’ LINES OF 2 ½”, INTO (1) 100” LINE OF 2 ½”

PP = ?



SIAMESE LINES (EQUAL LENGTH)

PP = NP + TFL

STEP ONE:

DETERMINE NOZZLE PRESSURE

50 P.S.I.

SIAMESE LINES (EQUAL LENGTH)

STEP TWO:
DETERMINE GPM FLOW

$$GPM = 30\ d^2 \sqrt{NP}$$

SIAMESE LINES (EQUAL LENGTH)

$$GPM = 30\ d^2\ \sqrt{NP}$$

1 1/8" TIP @ 50 P.S.I.

$30\ (1.125)^2\ X\ 7$

$30\ (1.27)\ X\ 7$

$38.1\ X\ 7 = 266.70$

ROUNDED 270 GPM

SIAMESE LINES (EQUAL LENGTH)

FOR EQUAL LENGTH DIVIDE FLOW AND CALCULATE FOR ONE LINE

GPM $\frac{270}{2}$ = 135

135 ROUNDED TO NEAREST 10 = 140

LINE (A) GPM = 140

SIAMESE LINES (EQUAL LENGTH)

STEP THREE :

CALCULATE FRICTION LOSS RATE (FLR)

SIAMESE LINES (EQUAL LENGTH)

LINE (A)

140 GPM

FLR = $2Q^2$

$2\ (\frac{140}{100})^2$

$2\ (1.4)^2$

$2(1.96) = 3.92$

FLR = 4

LINE (B)

270 GPM

FLR = $2Q^2$

$2(\frac{270}{100})^2$

$2(2.7)^2$

$2(7.29) = 14.58$

FLR = 15

SIAMESE LINES (EQUAL LENGTH)

STEP FOUR:

DETERMINE LENGTH

L = LENGTH

LINE (A)

200”

$$L = \frac{200}{100}$$

LINE (A) L = 2

LINE (B)

100”

$$L = \frac{100}{100}$$

LINE (B) L = 1

SIAMESE LINES (EQUAL LENGTH)

STEP FIVE:

DETERMINE TOTAL FRICTION LOSS

$$TFL = FLR\ (A) \times L\ (A) + FLR\ (B) \times L\ (B)$$

SIAMESE LINES (EQUAL LENGTH)

LINE (A)

TFL = FLR X L

FLR = 4

L = 2

TFL = 4 X 2

TFL = 8

LINE (B)

TFL = FLR X L

FLR = 15

L = 1

TFL = 15 X 1

TFL = 15

TFL = FLR (A) X L (A) + FLR (B) X L (B)

TFL = 8 + 15

TFL = 23

SIAMESE LINES (EQUAL LENGTH)

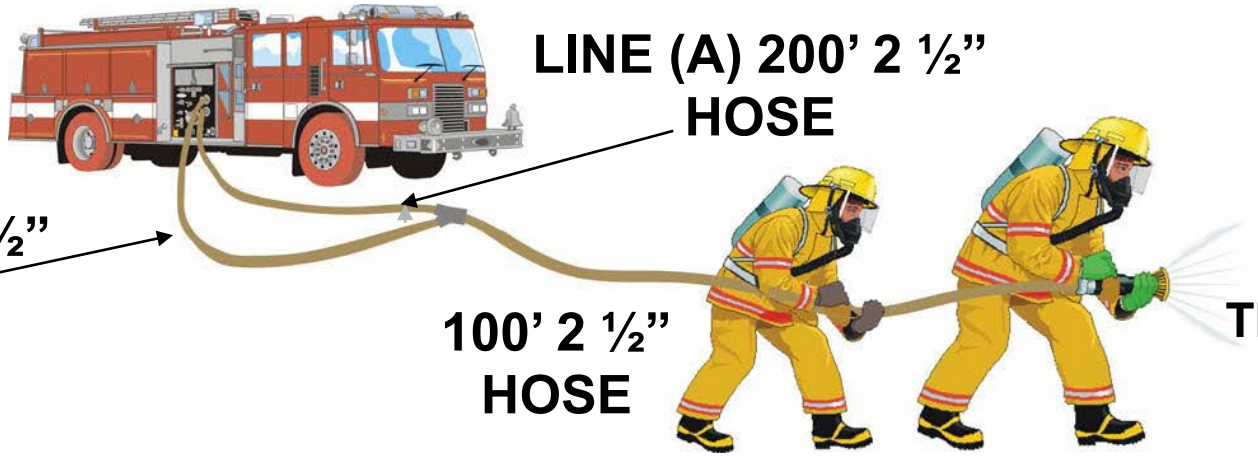
STEP SIX:

DETERMINE PUMP PRESSURE

PP = NP + TFL

PP = 50 + 23

PP = 73



SIAMESE LINES (UNEQUAL LENGTH)

AVERAGE THE LENGTHS AND CALCULATE FLOW

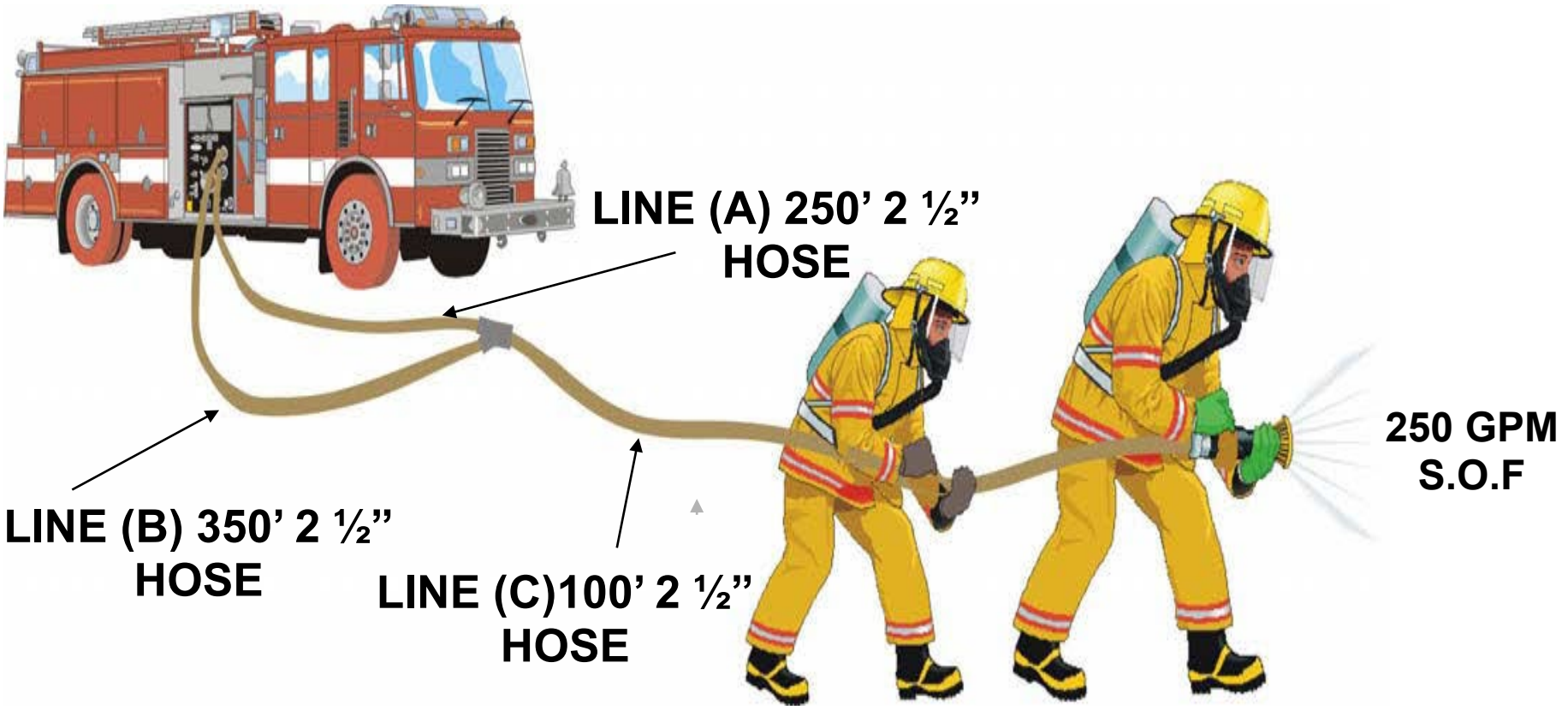
SIAMESE LINES (UNEQUAL LENGTH)

EXAMPLE:

250 GPM S.O.F. NOZZLE CONNECTED TO 100 OF 2½" HOSE AND TWO SIAMESE LINES.

SIAMESE LINE(A) 250" OF 2 ½" HOSE SIAMESE LINE (B) 350" OF 2 ½" HOSE

SIAMESE LINES (UNEQUAL LENGTH)



SIAMESE LINES (UNEQUAL LENGTH)

PP = NP + TFL

STEP ONE:

DETERMINE NOZZLE PRESSURE

NP = 100 P.S.I.

SIAMESE LINES (UNEQUAL LENGTH)

STEP TWO:

DETERMINE GPM FLOW

LINE(C) GPM = 250

FLOW THROUGH ONE SIAMESE LINE

$$\frac{\text{TOTAL FLOW}}{2} \qquad \frac{250}{2}$$

LINE(AB) FLOW =125 GPM

ROUNDED GPM FLOW THROUGH ONE SIAMESE LINE = 130 GPM

SIAMESE LINES (UNEQUAL LENGTH)

STEP THREE:

DETERMINE FRICTION LOSS RATE (FLR)

$$FLR = 2Q^2$$

SIAMESE LINES (UNEQUAL LENGTH)

SIAMESE LINE (AB)

$FLR = 2Q^2$

$FLR = 2(\frac{130}{100})^2$

$FLR = 2(1.3)^2$

$FLR = 2(1.3 \times 1.3)$

$FLR = 2(1.69)$

$FLR = 3.38$

$FLR = 3$

LINE (C)

$FLR = 2Q^2$

$FLR = 2(\frac{250}{100})^2$

$FLR = 2(2.5)^2$

$FLR = 2(6.25)$

$FLR = 12.5$

$FLR = 13$

SIAMESE LINES (UNEQUAL LENGTH)

STEP FOUR:

DETERMINE AVERAGE LENGTH OF SIAMESE LINES

WHEN AVERAGE COMES TO A ¼ OR ¾ ROUND OFF TO ½ OR 1 RESPECTIVELY

SIAMESE LINES (UNEQUAL LENGTH)

AVERAGE LENGTH OF SIAMESE LINES:

$$\frac{L(A) + L(B)}{2}$$

LENGTH 250 + 350 = 600

$$\frac{600}{2}$$

AVERAGE LENGTH = 300

L = 3

SIAMESE LINES (UNEQUAL LENGTH)

STEP FIVE:

DETERMINE TOTAL FRICTION LOSS (TFL)

SIAMESE LINES (UNEQUAL LENGTH)

$$TFL = FLR(AB) \times L(AB) + FLR(C) \times L(C)$$

SIAMESE LINES (UNEQUAL LENGTH)

LINE (AB)

FLR(AB) X L(AB)

3 X 3

9

LINE (C)

FLR(C) X L(C)

13 X 1

13

TFL = FLR(AB) X L(AB) + FLR(C) X L(C)

TFL = 9 + 13

TFL = 22

SIAMESE LINES (UNEQUAL LENGTH)

STEP SIX:

DETERMINE PUMP PRESSURE

PP = NP +TFL

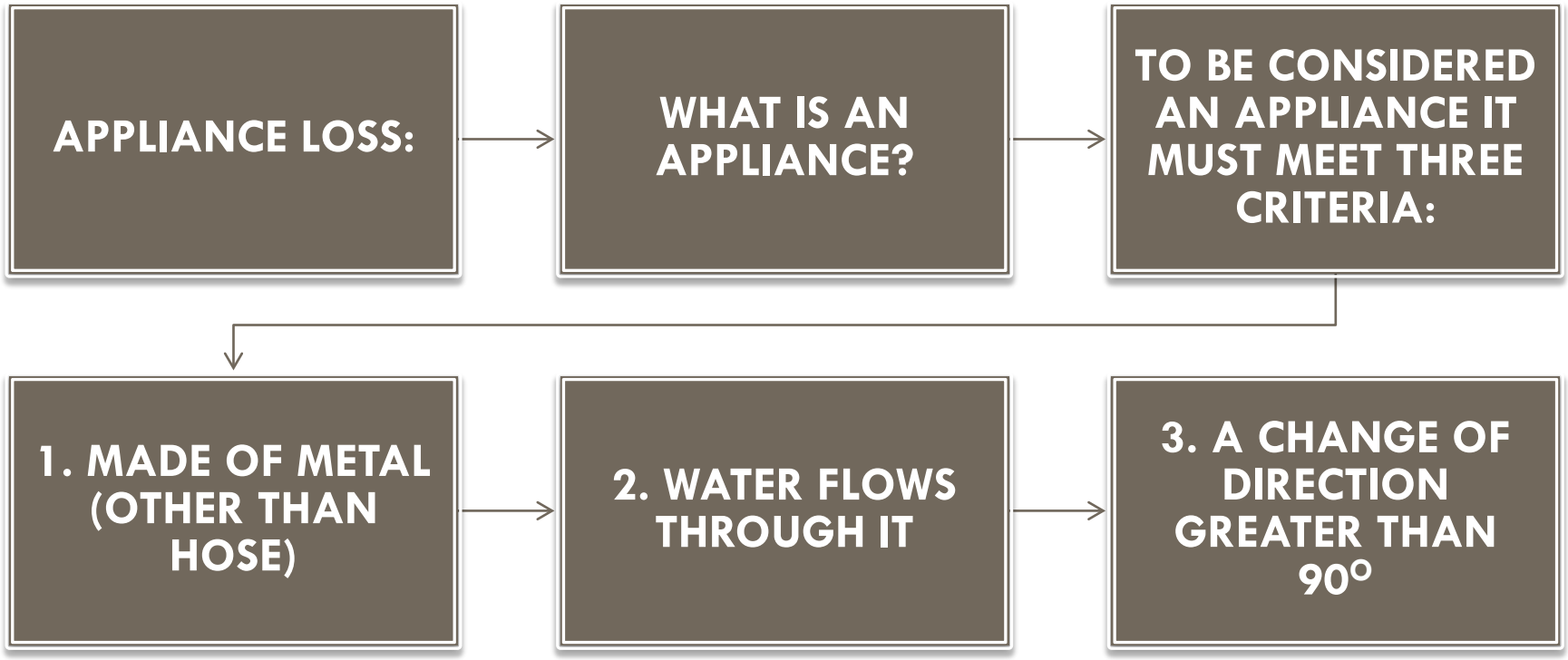
PP = 100 + 22

PP = 122

OTHER FACTORS NECESSARY TO DETERMINE PUMP PRESSURE

- NOZZLE PRESSURE
- GPM FLOWING (or SIZE OF THE NOZZLE)
- SIZE OF HOSE
- LENGTH OF HOSE IN LAY
- ELEVATION DIFFERENTIAL
- APPLIANCE LOSS
- SPRINKLER (or STANDPIPE) SYSTEM LOSS
- LADDER SYSTEM LOSS

OTHER FACTORS NECESSARY TO DETERMINE PUMP PRESSURE



OTHER FACTORS NECESSARY TO DETERMINE PUMP PRESSURE

APPLIANCE LOSS:

ALLOW **15 P.S.I.** APPLIANCE LOSS WHEN USING A DELUGE SET OR MONITOR

OTHER FACTORS NECESSARY TO DETERMINE PUMP PRESSURE

STANDPIPE SYSTEM LOSS:

ALLOW 25 P.S.I. FOR STANDPIPE SYSTEM SYSTEM LOSS (SL) REGARDLESS OF SIZE

ADD 5 GRAVITY LOSS (GL) PER FLOOR INCLUDING THE FLOOR THE NOZZLE IS ON.

DO NOT COUNT THE FIRST FLOOR

OTHER FACTORS NECESSARY TO DETERMINE PUMP PRESSURE

SPRINKLER SYSTEM LOSS SYSTEM LOSS:

ALLOW **25 P.S.I.** FOR STANDPIPE SYSTEM SYSTEM LOSS (SPR. L)

ADD **5** GRAVITY LOSS (GL) PER FLOOR

INCLUDING THE FIRST FLOOR

OTHER FACTORS NECESSARY TO DETERMINE PUMP PRESSURE

LADDER SYSTEM LOSS:

ALLOW 25 P.S.I. FOR LADDER SYSTEM LOSS (LSL)

PRE-PLUMBED TRUCKS ONLY

NOT PRE-PLUMBED IS AN APPLIANCE

APPLIANCES

ALLOW 15 PSI APPLIANCE LOSS WHEN USING A DELUGE SET OR APPLIANCE NOZZLE

APPLIANCES

DISCHARGE IS DIRECTLY OFF THE PUMP.

NO HOSE FRICTION LOSS

CALCULATIONS NEED TO BE MADE

APPLIANCES

EXAMPLE: 1 ¾” TIP FROM APPARATUS MOUNTED DECK GUN

APPLIANCES

EXAMPLE: 1 ¾” TIP FROM APPARTUS MOUNTED DECK GUN

INTIAL PUMP PRESSURE: 80 PSI

APPLIANCES

PP = NP + AL

NP = 80 AL = 15

PP = 95

The End