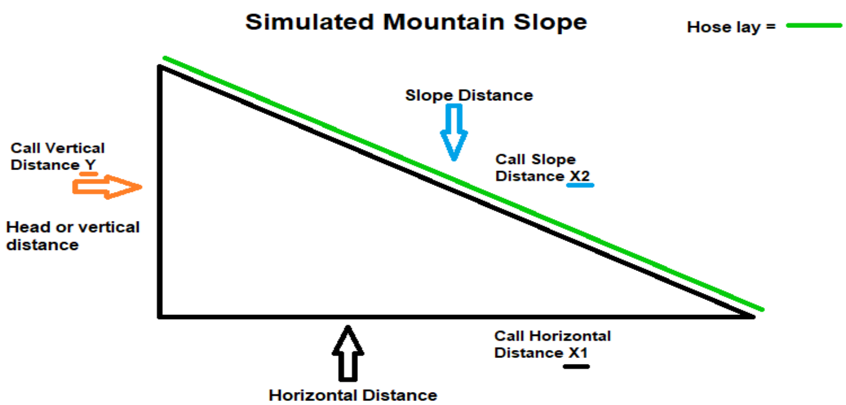
Mark III Pump Capacity Cheat Sheet

Example Sheets on pages 6 & 7 for the below exercise

1. Find the X_1 distance from your hose lay layout.



Use the Equation, Horizontal $= X2^2 - y^2 = X1^{2,}, \sqrt{X1^2} = X1$

2. Find the Slope Ratio using the Equation: $Slope\ Ratio = {}^{Y}/_{X1}$
3. Determine the needed flow in GPM & then perform the hydraulic PDP/Engine Pressure Calculations as normal. $Ep\ or\ PDP = Np + Fl \pm Hp$. This Example: A Hose lay is 18,000 feet in distance and has an elevation gain of 2,000 feet. Branch needs to have 60 GPM (for Btu capacity) supplied to keep up with a firing operation. Separate Pumps will supply hand lines with nozzles so do not factor Nozzle pressures at 100 psi! The PDP would be 3,136 psi for a single line or 1,444 psi for parallel lines. (When Stage Pumping, count Np at 10 psi or less).
4. Locate on the Appropriate Pump Curve, the Flow in GPM on the bottom, then move vertically upward to the limit line, then left 90 degrees and read the maximum attainable pressure for that particular flow. Write this figure down. This does NOT have to be 100% accurate. Ex: For the Standard Mark 3, for 60 GPM of flow on the bottom scale, moving vertically to the limit line(grey line), and then turning left we can read approximately 170 psi of max attainable pressure. 170 is what you will use.
5. Determine the Number of Pumps required by taking the determined PDP from #3, and Dividing this by the Maximum Attainable pressure as determined in #4. You will always have options & variables to work with in this phase. First, if calculated for a single hose line, take that figure and divide it by the Max attainable pressure, in this case, the figure of 170 psi. Do not add Nozzle pressure, the PDP equation already accounts for this.

$No. of\ Pumps = \frac{3{,}136}{170} = 18.5$ for a <u>single hose line</u> then round to the next whole number

$No. of\ Pumps = \frac{1{,}444}{170} = 8.5$ for a <u>parallel hose line</u> then round to the next whole number

6. Determine initial Pump distance spacing. Divide the hose lay distance by the number of pumps calculated from #5. This would work out as shown below.

Single line hose lay, Pump Spacing = $\frac{18{,}000}{19\ pumps} = 947ft$, (*950 ft*)

Parallel line hose lay, Pump Spacing = $\frac{18{,}000}{9\ pumps} = 2{,}000\ ft$

7. Verify Head and Friction Loss figures for the distances determined from <u>#6</u> using the slope ratio to verify head and head pressures for the computed distances.

Head at 947 feet is: $947\ x\ .1118 = 105.8\ ft\ of\ head$, Head Pressure required is 105.8 x .434 = 45.9 psi.

Head at 2,000 feet is: $2{,}000\ x\ .1118 = 223.6\ ft\ of\ head$, Head Pressure required is 223.6 x .434 = 97 psi.

Friction loss for 947 (reduced to 900) feet of 1 ½" single hose at 60 GPM is 12.6 x 9 = 113 psi.

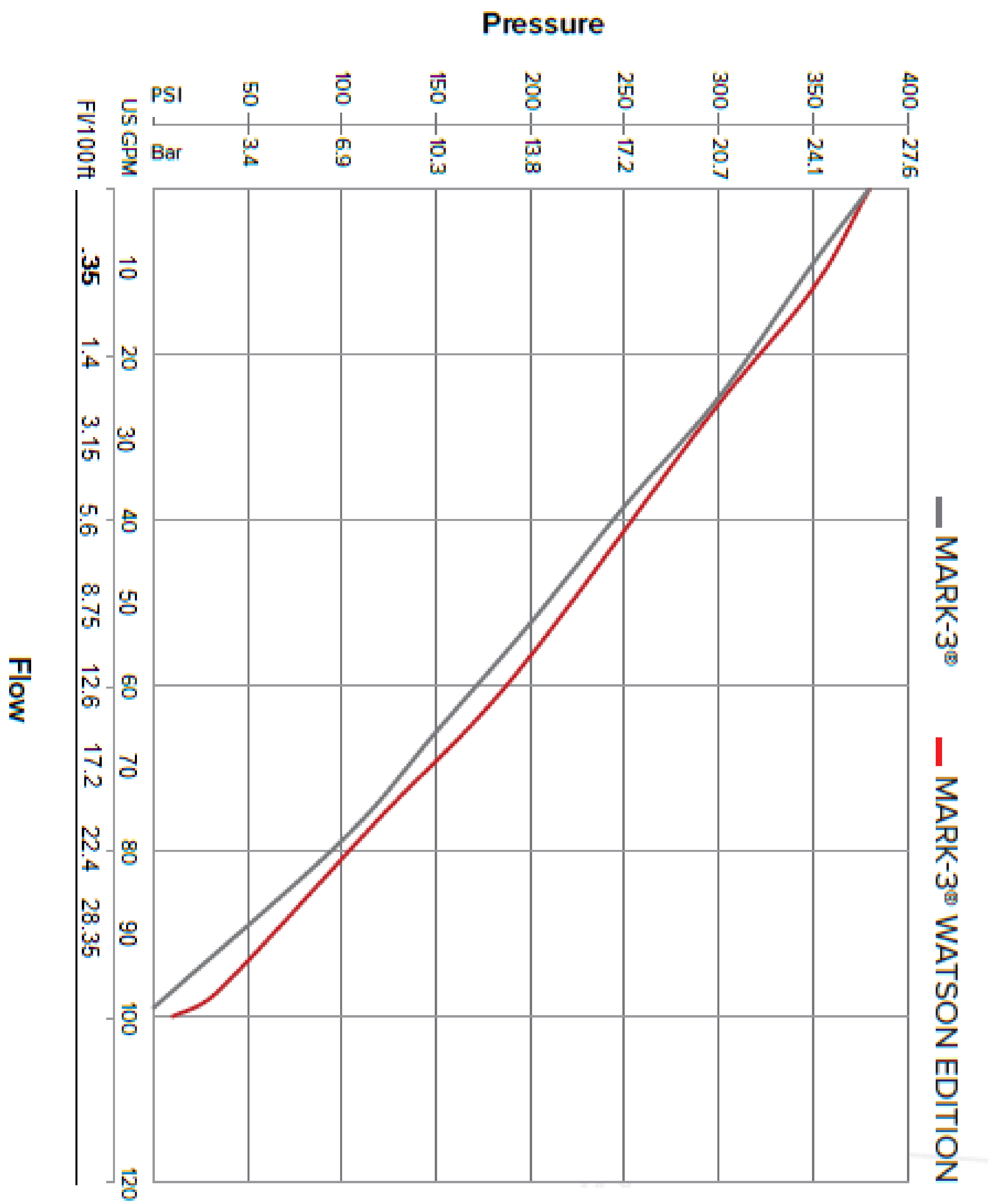
Friction loss for 2,000 feet of 1 ½" parallel hose at 60 GPM is 3.2 x 20 = 64 psi.

Head and Friction loss pressures added:

Single hose = 158 psi + 5 psi Np = 163

Parallel hose = 161 psi + 5 psi Np = 166

The only Caveat is with odd Friction loss distances, you have to use what you have on hand or can obtain. If you can obtain 50-foot sections of hose, then use the actual friction loss figures for the 947-foot distance as used here. Otherwise, you have to reduce or increase distances and then subsequently, the number of pumps will likely go up or down by 1 as well.


Pressure
PSI
Bar
50 3.4
100 6.9
150 10.3
200 13.8
250 17.2
300 20.7
350 24.1
400 27.6
US GPM
Ft/100ft
10 .35
20 1.4
30 3.15
40 5.6
50 8.75
60 12.6
70 17.2
80 22.4
90 28.35
100
120
Flow
MARK-3®
MARK-3® WATSON EDITION

Section 1

These figures only relate to the pump curve on page 3. However, this process is used in all scenarios you'll encounter. Adjust accordingly.

(Item numbers 1-11 are obtaining the Total Hose-lay information and pressures required)

1. Flow Demand From Pump Curve: __________

2. Max Attainable PSI from Pump Curve: __________

3. Fl from Pump Curve for associated flow: _________ (psi per 100 feet)

4. Length of Hose lay distance ($X2$): ____________

5. Height of vertical (y): ____________

6. ($X2^2$ - Y^2) = ______________________, $\therefore \sqrt{\rule{0pt}{1em}}$ ________________________

= (X1) = ________________

7. Slope Ratio = $\frac{Y}{X1}$ = ___________

8. Head Pressure required: _______________

9. Friction loss psi required: _______________

10. Nozzle pressure used: ________________

11. Total EP or PDP: _______________

Number of Pumps Required = PDP / Max attainable pressure from pump curve (#10)

$$\frac{PDP}{Pump\ Curve\ Pressure} \xrightarrow{=} \frac{\qquad\qquad}{Pump\ Curve\ Pressure} \xrightarrow{yields}$$ __________ No. Pumps

Item 6 shown above should be $(X2^2 - Y^2)$

Section 2

(Items 12-16 are obtaining the individual section pressures)

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12. Pump Spacing = $^{Hoselay\ Distance}/_{Number\ of\ Pumps} =$ _____________$ft.$

Spacing distance / 100 = Number of sticks of 100 foot hose = _____________

12A. Fl for Distance = No. of sticks x Fl per stick from Pump Curve = _____________

(This is your Head in feet for this distance).

13. Pump Space Distance x Slope Ratio = ____________x____________=_____________

(Use real numbers 1st, then round to the nearest whole stick & use those figures above for head and head pressure calculations for that particular point, the Np will become your variable pressure to adjust.)

14. Head Pressure for #13 above is : (*Head x .434 = Hp*) = _______________

(Remember, Np's used should be under 10 psi if stage pumping!)

15. Section PDP = Hp + Fl + Np = for this section = ______________

16. Section PDP x No of sections (No. of Pumps) should nearly equal the original PDP for the scenario.

Section PDP x No. Sections = __________________

(This should be close to the total hose-lay PDP initially calculated in section 1)

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Section 1

These figures only relate to the pump curve on page 3. However, this process is used in all scenarios. Adjust accordingly.

(Item numbers 1-11 are obtaining the Total Hose-lay information and pressures required)

1. Flow Demand From Pump Curve: 60
2. Max Attainable PSI from Pump Curve: 170
3. Fl from Pump Curve for associated flow: 12.6 (psi per 100 feet)
4. Length of Hose lay distance ($X2$): 18,000
5. Height of vertical (y): 2,000
6. $(X^2 - Y^2)$ = 320,000,000.0, $\therefore \sqrt{320{,}000{,}000}$

= (X1) = 17,888

7. Slope Ratio = $\frac{Y}{X1}$ = .1118
8. Head Pressure required: 868
9. Friction loss psi required: 2,268
10. Nozzle pressure used: 5 psi
11. Total EP or PDP: 3,141

Number of Pumps Required = PDP / Max attainable pressure from pump curve (#10)

$\frac{PDP}{Pump\ Curve\ Pressure} \xrightarrow{=} \frac{3{,}141}{170} \xrightarrow{yields}$ 19 No. Pumps

Item 6 shown above should be $(X2^2 - Y^2)$

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Section 2

(Items 12-16 are obtaining the individual section pressures)

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12. Pump Spacing = $Hoselay\ Distance / Number\ of\ Pumps$ = ___947___ $ft.$

Spacing distance / 100 = Number of sticks of 100 foot hose = ___9.47___

12A. Fl for Distance = No. of sticks x Fl per stick from Pump Curve = ___119___

(This is your Head in feet for this distance).

13. Pump Space Distance x Slope Ratio = ___947___ x ___.1118___ = ___105.8___

(Use real numbers 1st, then round to nearest whole stick & use those figures for above for head and head pressure calculations for that particular point, the Np will become your variable pressure to adjust.)

14. Head Pressure for #13 above is : (*Head x .434 = Hp*) = ___45.9___

(Remember, Np's used should be under 10 psi if stage pumping!)

15. Section PDP = Hp + Fl + Np = for this section = ___119 +46+5 = 170___

16. Section PDP x No of sections (No. of Pumps) should nearly equal original PDP for scenario.

Section PDP x No. Sections = ___19 x 170 = 3,230___

(This should be close to the total hose-lay pdp initially calculated in section 1)

Page 5

Item 16, would match the computed number if we multiplied 18.476 x 170 = 3,140.92 (the real numbers) instead of rounding them.

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