I'm not a robot

Modified on: Wed, 6 Mar, 2024 at 11:00 AM Friction Loss ExplainedFriction loss is the loss of pressure in the tubing or pipe caused by friction between water and the inner walls of the tubing. The factors that influence friction loss in irrigation tubing include: flow rate, the materials that make up the tubing, the length of the tubing and its diameter. ,Essentially, the more flow you have going through the tubing, and the faster it is moving, the greater the loss of pressure will be. Likewise, longer lengths of pipe and smaller diameters of tubing can expect to experience great losses of pressure from friction. Too much friction loss can cause pressure to drop to such a degree that the system may not operate as it should.FlowIn regards to pressure loss, you can break flow down to two separate variables, velocity and volume. Velocity is measured in feet per second (FPS) and flow is measured in gallons per minute or gallons per hour (GPM / GPH). Larger volumes and faster movement of water incur greater losses of pressure from friction.MaterialsThe material construction of the tubing influences friction loss. The rougher the material, the greater the friction. In general, plastic tubing types (polyethylene, PVC, PEX, etc) experience less friction than metal (copper, steel, etc) types. Tubing LengthThe longer the distance the water must travel, the more friction it will encounter. This is usually expressed in linear feet. Fittings (tees, elbows) and turns also cause friction loss. Most DIYers can disregard the loss from fittings, but larger systems seeking to be as efficient as possible should account for losses from fittings in their planning.Tubing DiameterLarger tubing inside diameters experiences less friction. This is because a lower percentage of the water comes into contact with the walls of the tubing. For the most part, it is this contact with the walls that causes frictions, thus a larger diameter tubing enjoys lower rates of pressure loss from friction.Importance of Calculating Friction Loss CostsThe performance of the system is the main reason to calculate friction loss in a system. If too much pressure is lost from friction, there may not be enough to operate the emitters further down the line. Even if there is sufficient pressure to operate the emitters, it may not be enough to keep them uniform with the rest of the system; this can cause issues like plants further down the line not receiving enough water (or plants closer to the water source receiving too much if run time is increased).Another factor, though not as critical as the above, is also significant: cost. If you do not calculate friction loss, you may end up purchasing a tubing diameter thats larger than what you need and thus end up paying more than necessary. On the other side of that, if you purchase tubing thats too small in diameter, it will likely have to be replaced. The costs of replacing tubing are significantly higher, as there is the lost cost of the initial roll of tubing, the time spent to install it, and possibly losses from the crop suffering from poor irrigation system performance.Planning ahead of time will not only save you money, but also help ensure good system performance.Protection of ComponentsAnother reason to account for friction loss is protection of components. High water velocity can cause damage to valves, fittings, emitters and other components in an irrigation system. If the water velocity is too high you can experience whats known as water hammer. It is an apt name, as any time you hear that sound it is the water hammering into a component, be it a valve, fitting, the walls of the tubing, or even a sprinkler or emitter. This hammering causes damage over time. High velocities can also displace the tubing due to movement; this displacement can cause damage to the outside of the tubing. Very high velocities can even reach erosion levels and cause damage quickly. This wont be a concern for most DIYers unless the system is larger, but still something to account for to ensure the longevity of the parts in the system. A general rule is to make sure the velocity is not much higher than 5 per second (5 feet per second). This is somewhat arbitrary (in that you wont find anything official) but 6 per second or less also improves the aesthetic in that the sound of the water moving through the tubing is lower at this velocity. This is one reason why you see recommendations in keeping the flow rate in tubing to 200 GPH or less 200 GPH going through poly tubing has a velocity of about 5 per second. This recommendation, though not a hard and fast rule of the industry, is designed to keep friction loss and velocity reasonable for both performance and longevity.Its important to note that, in much larger systems using a very large diameter of tubing or pipe, the velocity is also important for personnel safety. A high velocity of water in a 10 pipe could even cause significant injury, particularly if it is a metal pipe. Calculating Friction LossGoogling how to calculate friction loss brings up an overwhelming amount of information, from general guidelines (like the 200 GPH maximum for tubing) to complex mathematical formulas. Performing the math yourself could be beneficial if youre designing a large system, but if youre a home DIYer the friction loss calculator we have on our site will be more than sufficient; all you need to know to utilize the calculator is the system flow rate in GPH, the total linear length of the tubing in feet and the diameter of the tubing. Here is the link to the calculator: Pressure Loss Calculator. If youd like to calculate the velocity, you can use Washington State Universitys calculator. They have two separate calculators; one to determine velocity in feet per second and another to determine what tubing size would be needed to keep velocity at 5 per second or less. I recommend using the second calculator as it will be more accurate in regards to what tubing size is needed. For example, if you use the velocity calculator and put in 3.33 GPM (200 GPH) on the flow rate line and 0.5 on the tubing diameter line, youll get a result of 5.44 per second. This is because they are using an actual inch tubing size on that calculator, but tubing tends to be larger than an actual half inch our tubing, for example, has an inside diameter of .600, which is a very common inside diameter for irrigation tubing labeled 1/2.. Using the second calculator will give you an inside diameter to use. For example, if you input 8 GPM on the flow line, it will report that you need a 0.8 inside diameter tubing to keep velocity at 5 or less. 0.8, while not an actual tubing size, is close to common tubing sizes. Our tubing, for example, has an inside diameter of .820. Here is the link to WSUs calculator: WSU Pipe Water Velocity and Minimum Pipe Diameter Calculator.Hunter Industries, a manufacturer of premium irrigation supplies, has created a short booklet that provides charts and formulas for friction loss in several schedules and classes of IPS PVC and Polyethylene. For anyone looking to truly account for friction loss, this resource will prove invaluable. It can be found at this link: Hunter Industries Tech / Friction Loss Tables.Concluding ThoughtsAccounting for friction loss is important to save on costs, time and to help ensure proper system performance. For the home DIYer, following the general guidelines will typically be more than sufficient; larger commercial growers, who have the most on the line, stand to gain the most by calculating and planning for friction loss. Online calculators can do the math for the end-user with just a little bit of input which should be easy to attain. Thank you for reading, if you have any questions, comments or feedback, please do not hesitate to Contact Us. We read and reply to every message we receive and would love to assist with your questions and learn from your feedback. Did you find it helpful? Yes NoFind the Friction loss of 600 of 2 1/2 hose flowing 250GPM.How well did you know this?234 Find the fiction loss of 700 of 2 1/2 hose flowing 200GPM.How well did you know this?234 Find the friction loss of 1000 of 2 1/2 hose flowing 300GPM.How well did you know this?234 Find the friction loss of 400 of 1 1/2 hose flowing 100GPM.How well did you know this?234 Find the friction loss of 300 of 1 hose flowing 30 GPM.How well did you know this?234 Find the friction loss of 400 of 2 1/2 hose connected to 200 of 1 1/2 hose connected to 300 of 1 hose flowing 30 GPM.How well did you know this?234 Find the friction loss of 600 of 4 hose flowing 1000 GPM.How well did you know this?234 Find the friction loss of 500 of 4 hose flowing 800 GPM.How well did you know this?234 Practice Problem #1Find the pump discharge pressure (PDP) of 700 of 2 1/2 hose flowing at 250 gpm.How well did you know this?234 Practice Problem #2Find the PDP of 400 of 1 1/2 hose flowing at 125 gpm.How well did you know this?234 Practice Problem #3Find the PDP of 300 of 1 hose flowing at 30 gpm.How well did you know this?234 Practice Problem #4Find the friction loss of 300 of 2 1/2 hose connected to 300 of 1 1/2 hose connected to 500 of 1 hose flowing at 30 gpm.How well did you know this?234 Practice Problem #5Find the PDP of 500 of 4 hose flowing at 1,000 gpm to a portable deluge.How well did you know this?234 Practice Problem #6Find the PDP of a turret operation flowing at 1,000 gpm.How well did you know this?234 Practice Problem #7Find the PDP of the following Rapid Attack Monitor (RAM) Operation.How well did you know this?234 Practice Problem #8Find the PDP of the following RAM Operation. Practice Problem #9Find the PDP of 300 of 2 1/2 hose flowing at 200 gpm from a fog nozzle that is 60 above the fire pump. Practice Problem #10Find the PDP of 200 of 1 1/2 hose flowing at 100 gpm from a fog nozzle that is 70 below the fire pump. Practice Problem #11Find the PDP of 300 of 1 1/2 hose flowing at 185 gpm from a barrel tip nozzle that is 100 above the fire pump. Practice Problem #12Find the PDP of the following wyed operation.300 2 1/2 wye 150 1 1/2 125 gpm 75 NP 250 1 1/2 125 gpm 75 NP Practice Problem #13Find the PDP of the following wyed operation.600 1 1/2 wye 300 1 30gpm 100psi NP 600 1 30gpm 100psi NP Practice Problem #14Find the PDP of the following wyed operation.400 2 1/2 wye 200 1 1/2 125 gpm 75NP 400 1 20 gpm 100 NP Practice Problem #15Find the PDP of the following Siamese deluge operation.400 2 1/2350 2 1/2 } Deluge 750 gpm barrel tip450 2 1/2 One of the pump operators primary goals is to provide the fire attack crew with the necessary water flow to get their job done. There are plenty of things that the pump operator must get done in the early stages of a fire, and none are more important than this.One of the pump operators critical tasks is determining what pump discharge pressure to set for each supply or hand line. To determine this, the pump operator must first know the total gallons per minute flow, that is, the desired result on the working end of the hose.The type of nozzle being used smooth-bore, automatic nozzle or adjustable gallonage will determine the gpm. Once the pump operator knows what the desired gpm is, then they must know what size hoses are being used, the lengths of the hoses and any appliances that are part of the hose layout, such as a gated wye.Armed with that information, the pump operator can then calculate the friction loss, the remaining ingredient for getting the right mixture to their firefighting colleagues.Friction is the force resisting the relative motion of solid surfaces, fluid layers and material elements sliding against each other. Friction loss is the pressure loss due to the friction.In its fire service application, the friction is water sliding against the interior surfaces of the pump, any connected appliances gated wyes, manifolds or a water thief standpipes and fire hose.Pump operators should commit these five friction loss principles to memory: All fire hose has friction loss.There is no set friction loss for any one size of hose.Friction loss is determined by the gpm flowing, the size of the hose and the length of the hose. All three factors must be considered.Most of the fog nozzles have flow rates ranging from 95 to 200 gpm. Dont get stuck on one flow rate; the fire will dictate which flow rate to use.Its not psi that puts the fire out; its providing the correct gpm that the incident commander needs.Getting comfortable with friction lossTruly understanding friction loss is critical for all pump operators, and its frequently presented to new pump operators as something akin to understanding quantum physics. In reality, understanding friction loss and its place in properly supplying hose lines and fire streams is not that daunting of a task.The basic challenge for the pump operator is to develop the proper pump discharge pressure necessary to overcome the friction loss in a fireground set up to ensure that the firefighter on the nozzle will have the appropriate amount of water to suppress the fire.There are two ways to calculate friction loss: the theoretical method or the fireground method. The former uses mathematical equations, while the latter uses rules of thumb that dont require much in the way of mathematical calculations. Theoretical calculations are generally best used for pre-fire planning, developing specifications for pumping apparatus and calculating problems ahead of time, such as creating pump charts. Theoretical calculations are typically not an efficient means of calculating friction loss on fire scenes.Many times, instructors teaching pump operations bring out the theoretical method, along with its equations, at the beginning of the training process. Its their mistaken belief that knowing how the watch is constructed is important for the watch owner to know before they learn how to tell time using the watch.I was very fortunate at the beginning of my firefighting career to join a department where that was not the case.My pump operator instructors focused early on developing my skills in using such tools as the hand method for calculating friction loss. They also emphasized memorizing the friction loss for the pre-connected hand lines and typical hose layouts that I would encounter as a pump operator.A hose configuration that would be employed at an apartment or condominium complex, for example, was 200 feet of 3-inch supply hose, connected to a gated-wye, supplying two 13/4-inch fire attack lines of 200 feet each with a 100-psi adjustable fog nozzle on each line set for 150 gpm.The hand methodThis is an extremely valuable tool for both learning and teaching what the friction loss is for various sizes of hose and various gpm flows. Below is one example of a hand method for calculating friction loss in various sizes of hose. Using the hand method, for each 100-foot length of 1-inch hose flowing 200 gpm, the friction loss is 48 psi: 2 x 4 x 6 = 48 psi. For a 3-inch supply line flowing 300 gpm, the friction loss per 100-foot section would be 9 psi: 3 squared equals 9 psi.Memorizing this much simpler than it sounds. Just memorize the friction loss for the gallonage settings on the nozzles used in your department. Most 100-psi adjustable fog nozzles for use with 1-inch hose have four settings: 95 gpm, 125 gpm, 150 gpm and 200 gpm.All you must remember is the friction loss for each, 14, 24, 35 and 62, respectively. Those are the amounts of friction loss per 100 feet of hose based on the gallonages above. Thus, the friction loss per 100 feet of 1-inch hose when flowing 95 gpm is 14 psi; for a 200-foot line, your friction loss is 28. It works the same way for the other gallonage settings. Change the flow setting on the nozzle to 150 gpm on the same 100-foot line and the friction loss is 35, if you increase the hose length to 200 feet, the friction loss becomes 62 psi.Dont forget, this is just the friction loss in the hose; it is not the pressure that you must generate from the pump at the engine. To figure the required discharge pressure, add up all friction loss in the hose and any appliances plus the required nozzle pressure.Thus, for that apartment complex layout I mentioned earlier, the calculation would look like this: Know your friction loss pointsDo your homework about the different hose loads, appliances and nozzles used in your department and what each contributes to friction loss, that is, what are the friction loss points. A best practice employed by many skilled pump operators is creating a cheat sheet containing what those friction loss points look like. My fire service colleague with the Henrico County (Va.) Division of Fire, Taylor Goodman, offers another perspective on friction loss. There is friction loss within the internal plumbing of the fire apparatus itself.Even pumpers ordered from the same manufacturer using the same spec can have differences in their internal plumbing, said Goodman, resulting in different required PDPs [pump discharge pressures] from one engine to another.Per Goodman, the only way to truly determine an accurate PDP for a specific pumper is to test each discharge with a flow meter. Time consuming, for sure, but more accurate.Goodman also said that some of the nations leaders in fire streams and their applications, such as Dennis LeGear, have determined that there is no common national standard in determining the internal diameter between manufacturers for different diameter attack lines.This creates several issues when you teach a nationally accepted method for determining friction loss, then put a flow meter on it and find that youre actually 20 pounds off, said Goodman.According to Goodman, theres a grassroots effort to update the standards, as well as working with the manufacturers, to bring some consistency to those internal diameters and anticipated friction loss within the internal plumbing of fire apparatus. Learn more about apparatus and pump operations This article, originally published in March 12, 2017, has been updated. Share copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. 1 Cubic foot of water weighs 62.5 pounds 1 Cubic foot of water contains 1,728 cubic inches 1 Cubic foot of water contains 7.5 gallons 1 Gallon of water contains 8.35 pounds 1 Gallon of water contains 231 cubic inchesHEAD AND ATMOSPHERIC PRESSURE1 foot of water exerts a back pressure of 0.434psiEXAMPLE: When working from a standpipe at a point 100 feet above the street, the engineer must provide 43.4psi to overcome the back pressure from the elevation.In addition, the engineer must provide pressure necessary to overcome friction loss and provide nozzle pressure. 1psi will elevate water 2,304 feet Atmospheric pressure at sea level is 14.7psi Theoretically, the maximum lift for drafting would be 34 feet This is determined by taking the atmospheric pressure (14.7psi) multiplied by the number of feet each psi lifts water (2,304 feet) to give 33.87 (34 feet). Practically speaking, lifts over 20 feet should not be attempted. 1 mercury (inches of vacuum) = 1.13 feet of lift 2ESTIMATING AVAILABLE WATER FROM A HYDRANTA recommended minimum of 10psi* should be maintained on the compound gauge when taking water from a hydrant. *This varies from recommendations in IFSTA Pumping Apparatus, Driver/Operator Handbook, 1st Edition The terms static pressure and residual pressure are familiar to every firefighter.However, the difference between them is all too often not properly understood. Static pressure, we say, is the pressure that exists on a given hydrant when no water is flowing. This pressure is the same pressure that is available at the water source. Whether the source be a gravity tank or a pumping station is not important. Once the hydrant is open and a flow of water is present, a drop in pressure will occur.This drop in pressure is due to the friction loss that is now occurring in the water main system between the water source and the pump. The larger the water main between the source of supply and the hydrant equals less friction loss. The remaining pressure on the main is that which we term residual pressure. Since we have friction loss on the suction side also, we again must consider the same factors as we considered on the discharge side. The farther the pumper in use is from the hydrant, the less usable pressure due to increased friction loss.The faster the water is moving (velocity), the greater the loss. If the flow from the hydrant is doubled, the friction loss will be 4 times as great. It is this factor that will enable the pump operator to tell how many lines the available water pressure will enable him/her to handle. EXAMPLE: The intake compound gauge showed 70psi before any lines are charged (static pressure) and a 2 line with a 250 GPM fog nozzle is then charged and the intake pressure drops to 67psi. This indicates the friction loss between the source of supply and the pump intake is 3psi with 250 GPM flowing.By applying the factor friction loss varies as the (flow) it is simple to calculate the number of lines of the same size the hydrant can supply. LINE GPM CALCULATION FOR PSI LOSS 1 250 3 2 500 Flow is twice the original (2) = 4 x 3psi drop = 12 3 750 Flow is triple the original (3) = 9 x 3psi drop = 27 4 1000 Flow is 4 times the original (4) = 16 x 3psi drop = 48 5 1250 Flow is 5 times the original (5) = 25 x 3psi drop = 75 The pressure required for 5 lines is greater than the available pressure and cannot be supplied. 3 Thus by noting the static pressure reading and applying the numbers 4, 9, 16 or 25 to the pressure drop of the first line, a Fire Apparatus Engineer can determine how many more lines of the same flow he/she can apply. As can be seen from the example, the Fire Apparatus Engineer could supply 3 additional or more 250 GPM lines for a total of 4 250 GPM lines with a residual pressure of approximately 22psi.In estimating available water, two things must be considered: 1. Quality/quantity of the water supply system2. Fire department connections to the system Although the following method can give inference to both, the primary concern is the water available for firefighting, as the fire engineer has connected to the system. The method employed uses the Second Friction Loss Rule, which states: In the same size hose, friction loss varies approximately as the square* of the velocity of flow. Therefore, if the velocity is doubled, friction loss is quadrupled.EXAMPLE 1 VELOCITY VELOCITY SQUARED #1 DROP TOTAL DROP Doubled = 2 4 3psi 12psi Quadrupled = 4 16 3psi 3psi Quintupled = 5 25 3psi 75psi EXAMPLE 2 VELOCITY VELOCITY SQUARED #1 DROP TOTAL DROP Doubled = 2 4 6psi 24psi Tripled = 3 9 6psi 54psi Quadrupled = 4 16 6psi 96psi Quintupled = 5 25 6psi 150psi *To square a number, multiply the number times itself To Estimate Available Water:1. Note the static reading2. Note the drop after discharging the first line3. Multiply the drop from the first line by the square of the velocity to see if the original flow may be doubled, tripled, etc. a. Multiply by 4 if doubling the flow b. Multiply by 9 if tripling the flow c. Multiply by 16 if quadrupling the flow d.Multiply by 25 if quintupling the flow 44. Subtract the total drop from the original static pressure, but do not take the Compound Gauge lower than 10psi5. Product from #3 and your original flow rate will determine the total flowCOMPONENTS OF A MOBILE WATER SUPPLY OPERATIONA. Apparatus a. Tanker/tender i. NFPA minimum 1. 1000 gallon capacity 2. 750 GPM ii. Construction features 1. Tank capacity and size 2. Chassis and axle loading 3. Engine and drive train type and size 4. Dump and vent size 5.Pump location and size 6. Tank type or style iii. Use 1. Combination a. Attack b. Supply 2. Shuttle a. Dump considerations b. Loading considerations c. Additional considerations depending on local conditions 3. Nurse (connected to pumper) b. Pumpers i. Pump capacity ii. Hose carried iii. Fittings and adapters iv. Use1. Pump at water source2. Unload tankers (power unload or nurse)3. Relay (open or closed)4. Fire attack 5 B. Portable tanks a. Function i. Reservoir ii. Dumping site for tanks b. Size i. 500-6,000 gallons ii. Circular or square c. Construction i. Folding synthetic ii. Floating collar d. Use i. Position and spotting for dumping and drafting ii. Level surface iii. Access and turn around C. Auxiliary equipment a. Portable pumps i. Light-weight 1. Easily carried to water source 2.Minimum manpower required ii. High volume at low pressure b. Loading and unloading dumps i. Special hoses or chutes ii. Jet drafts iii. Siphons or transfer devices iv. Low level strainers v. Fill devices vi. Cam-lock or quick connect couplings PUMP TESTS 1. Pre-service tests a. Certification test i. 2 hour 100% @ 150psi ii. hour 70% @ 200psi iii. hour 50% @ 250psi iv. 10 minutes 100% @ 165psi (overload or spurt test) b. Service test i. 20 minutes 100% @ 150psi ii. 10 minutes 70% @ 200psi iii. 10 minutes 50% @ 250psi 6 iv. 10 minutes 100% @ 165psi (optional) (overload or spurt test) A minimum of 10psi should be maintained on the compound gauge when taking water from a hydrant. 100% capacity @ 150psi net pump pressure 70% capacity @ 200psi net pump pressure 50% capacity @ 250psi net pump pressureCOMPUTING NET ENGINE PRESSURE1. Net Engine Pressure (NEP) is the measurement of the total work performed by the pump a. To lift water into the pump b. To discharge water from the pump2. Allowances are made for a. Friction loss in intake hose b. Height of lift3. Friction loss factors in hard suction hose and strainer (measured in psi): RATED CAPACITY OF PUMPER DIAMETER OF SUCTION HOSE FOR 10 FEET OF SUCTION HOSE FOR EACH ADDITIONAL 10 FEET OF SUCTION HOSE 500 GPM 4 6 Plus 1 4.5 3.5 Plus 0.5 750 GPM 4.5 7 Plus 1.5 5 4.5 Plus 1 1000 GPM 4.5 12 Plus 2.5 5 8 Plus 1.5 6 4 Plus 0.5 1250 GPM 5 12.5 Plus 2 6 6.5 Plus 0.5 1500 GPM 6 9 Plus 1 2 5 7 Plus 1 2 6 2 Plus 0.5 1750 GPM 6 12.5 Plus 1.5 2 5 6.5 Plus 1 2 6 3 Plus 0.5 2000 GPM 2 5 8 Plus 1.5 2 6 4 Plus 0.5 7COMPUTING NET ENGINE PRESSURE WHEN DRAFTING NEP = Suction Side Work + Discharge Side Work Work performed on the discharge side of the pump is indicated on the pumps discharge gauge Work performed on the suction side of the pump is determined by computing the following formula: Work (psi) = Lift (in feet) + Intake Hose Friction Loss (psi) 2.3 feet Steps: 1. Determine the lift (in feet) 2. Determine the friction loss in the intake hose used 3. Add lift and friction loss together 4. Divide by 2.3 (2.3 is the amount of lift (in feet) that 1psi of water pressure will support) EXAMPLE: A pumper is discharging 1000 GPM at a pressure of 142psi. The pumper is drafting water with a lift of 10 feet through 20 feet of 5 hard suction hose and strainer.What is the NEP? NEP = Suction Side Work + Discharge Side Work SS Work = 10 feet + 9.5psi = 19.5 ft. psi = 8.47psi 2.3 ft. 2.3 ft. Discharge Side Work = 142psi NEP = 8.47psi + 142psi NEP = 150psi 8DETERMINING THE PUMP DISCHARGE PRESSURES FOR THE SERVICE TEST NEP= Suction Side Work + Discharge Side Work To determine the pump discharge pressures for a service test, the Suction Side Work must be subtracted from the NEP. Pump Discharge Pressure (PDP) = NEP Suction Side Work EXAMPLE: A 1000 GPM pumper is to perform an Annual Service Test. What are the desired readings on the pump discharge gauge for the following tests? 1. 100% capacity test @ 150psi NEP 2. 70% capacity test @ 200psi NEP 3. 50% capacity test @ 250psi NEP The pumper is using 2 10 foot sections of 5 hard suction hose. The pump has been primed. The compound gauge reading is approximately 10 Hg. Steps: 1. Find the lift (10 Hg x 1.13 feet = 11.3 feet) 2. Find the friction loss in the hard suction hose (5 = 9.5psi) 3. Compute Suction Side Work SS Work = Lift + Fiction Loss = 11.3 feet + 9.5psi = 20.8 ft. psi = 9psi 2.3 ft. 2.3 ft. 2.3psi 4. Solve for Pump Discharge Pressure (PDP) NEP SS WORK PDP 1 150psi 9psi 141psi 2 200psi 9psi 191psi 3 250psi 9psi 241psi 9 COMPUTING NET ENGINE PRESSURE WHEN THE PUMP ISBEING SUPPLIED BY A POSITIVE PRESSURE WATER SOURCE (HYDRANT)1. No work is being performed on the suction side of the pump2. The incoming pressure added to the discharge pressure, produced by the pump, produces the total discharge pressure3. NEP the total work performed by the pump.Therefore, the incoming pressure must be subtracted for the discharge pressure (found on the discharge pressure gauge) to find the NEP of the pump NEP = Pump Discharge Pressure (PDP) Intake Pressure (IP) EXAMPLE: A pumper is being supplied by a hydrant. The compound gauge shows a residual pressure of 25psi and the discharge pressure is 175psi. What is the NEP? NEP = PDP IP = 175psi 25psi = 150psi NOTES FOR VARIOUS NOZZLEPRESSURES ON FOG NOZZLES GPM from fog nozzles at various pressure = Rated GPM x Desired Nozzle Pressure x 0.1 EXAMPLES: 250 GPM @ 80psi 120 GPM @ 80psi 120GPM @ 50psi x 9 x 9 x 9 2250 1080 840 x 0.1 x 0.1 x 0.1 225 GPM 108 GPM 84 GPM GPMs FROM CIRCULAR OPENINGS Computing GPMs from circular openings shall use the following formula: GPMs = 29.7d P Pressure d= diameter of orifice P= flow pressure (psi) of discharge stream 10 HAND LINES & MASTER STREAMS FAE will consider all flows up to 350 GPM to be considered HAND LINES. All flows over 350 GPM will be considered MASTER STREAMS. Nozzle Pressures Smooth Bore o Hand-held = 50psi o Master = 80psi Fogs (including fogs on master stream devices) o Most fogs = 100psi NOZZLE REACTION Newtons Third Law of Motion, For every action there is an equal and opposite reaction.As water leaves a nozzle under pressure, it causes a reactionary force in the opposite direction. The formula used for calculation of nozzle reaction is NR = 1.57DP. Relating to fog nozzles and master stream smooth bore tips, fireground nozzle reaction calculations can be computed at approximately the flow (measured in pounds).ANGLE OF DEFLECTION AND EFFECTIVE REACHThe reach of fire streams is affected by two variables: 1. Air resistance 2. Gravity The air resistance increases at an accelerated rate as the pressure is raised with the same tip. The greatest horizontal reach occurs at elevations of 30-40 degrees Maximum effective vertical reach of a fire stream occurs at 60-75 degrees The third floor may be said to be the highest floor to which streams may be thrown effectively from street level. (Casey, pg. 329) Moderate head and tail winds decrease reach 10-15%. 11 SOLID STREAM NOZZLES HAND LINES 50PSI NOZZLE PRESSURE (GPM) MASTER STREAMS 80PSI NOZZLE PRESSURE (GPM) 1 200 1 400 1 250 1 500 1 300 1 600 1 700 1 800 1 900 2 1000 ONE-EIGHTH () RULE change in nozzle diameter at 50psi nozzle pressure changes the flow by approximately 50 GPM. change in nozzle diameter at 80psi nozzle pressure changes the flow by approximately 100 GPM, up to and including 2 tips.FRICTION LOSS FORMULAS FOR 100 FEET OF HOSE HOSE DIAMETER FRICTION LOSS FORMULA 1 The FL in 2 hose at 4 times the stated GPM 1 (10 Q) + 10 2 (2 Q + Q) x 3 2 (2 Q + Q) 3 (2 Q + Q) x 4 3 (2 Q + Q) x 0.17 4 (2 Q + Q) x 0.1 4 (2 Q + Q) x 0.05 5 (2 Q + Q) x 0.03 *Q = GPM divided by 100 EXAMPLE: 1 hose flowing 100 GPM x 4 2 hose = 36psi =400 GPM 12FRICTION LOSS 1 HOSE To help simplify the computing of the friction loss in 1 hose, the FAE Committee has accepted a standard GPM and friction loss commonly used in the fire service (200 GPM and 30psi per 100 feet of hose). This standard will be used when teaching this course and for any testing requiring the computing of FL in 1 hose. The instructor may teach additional methods for computing FL in 1 hose, but all FAE testing will only reflect the use of the above standard. FRICTION LOSS 1 HOSE To help simplify the computing of the friction loss in 1 hose, the FAE Committee has accepted a standard GPM and friction loss commonly used in the fire service (150 GPM and 32psi per 100 feet of hose). This standard will be used when teaching this course and for any testing requiring the computing of FL in 1 hose. The instructor may teach additional methods for computing FL in 1 hose, but all FAE testing will only reflect the use of the above standard.FIELD HYDRAULICS 250 GPM fog nozzle on a 2 line = 15 pounds per 100-feet of friction loss 100 GPM fog nozzle on a 1 line = 30 pounds per 100-feet of friction loss 150 GPM fog nozzle on a 1 line = 32 pounds per 100-feet of friction loss ELEVATION Add 5psi for each floor of elevation (exclude one floor) Subtract 5psi for each floor below grade APPLIANCES Add 25psi for standpipe system and siamese Add 10psi for gated wyes and siamese Add 20psi for all master stream devices Add 20psi for in-line operations SPRINKLER SYSTEMS Sprinkler systems shall be maintained at 150psi pump discharge pressure Calculate the flow from sprinkler heads by using the following formula: o Flow (GPM) = pressure (at the sprinkler) + 15 13HYDRANT RESIDUAL PRESSURE A recommended minimum of 10psi should be maintained on the compound gauge when taking water from a hydrant FIELD HYDRAULICS Pump in CAPACITY when you are going to discharge over 50% of your pumpers capacity Pump in PRESSURE when you are going to have to develop a net pump pressure over 200psiFRICTION LOSS 2 RUBBER-LINED HOSE POUNDS OF FRICTION LOSS PER 100 FEET 200 GPM 200/100 = 2 2 x (2 x 2) + 2 = 10 pounds 300 GPM 300/100 = 3 2 x (3 x 3) + 2 = 21 pounds 400 GPM 400/100 = 4 2 x (4 x 4) + 2 = 36 pounds RED LINE 500 GPM 500/100 = 5 2 x (5 x 5) + 2 = 55 pounds 600 GPM 600/100 = 6 2 x (6 x 6) + 2 = 78 pounds 700 GPM 700/100 = 7 2 x (7 x 7) + 2 = 105 pounds 800 GPM 800/100 = 8 2 x (8 x 8) + 2 = 136 pounds 900 GPM 900/100 = 9 2 x (9 x 9) + 2 = 171 pounds 1000 GPM 1000/100 = 10 2 x (10 x 10) + 2 = 210 pounds 3 HOSE POUNDS OF FRICTION LOSS PER 100 FEET 200 GPM 200/100 = 2 2 x 2 x 2 + (2 x 0.4) = 4.0 pounds 300 GPM 300/100 = 3 3 x 3 x 2 + (3 x 0.4) = 8.4 pounds 400 GPM 400/100 = 4 4 x 4 x 2 + (4 x 0.4) = 14.4 pounds 500 GPM 500/100 = 5 5 x 5 x 2 + (5 x 0.4) = 22.0 pounds 600 GPM 600/100 = 6 6 x 6 x 2 + (6 x 0.4) = 31.2 pounds RED LINE 700 GPM 700/100 = 7 7 x 7 x 2 + (7 x 0.4) = 42.0 pounds 800 GPM 800/100 = 8 8 x 8 x 2 + (8 x 0.4) = 54.4 pounds 900 GPM 900/100 = 9 9 x 9 x 2 + (9 x 0.4) = 68.4 pounds 1000 GPM 1000/100 = 10 10 x 10 x 2 + (10 x 0.4) = 84.0 pounds 14 FRICTION LOSS Red line friction loss = 36 pounds. If friction loss goes over 36 pounds, a second line or larger diameter hose should be used. 3 HOSE 4 HOSE 2Q + Q x 0.17 = FL 2Q + Q x 0.10 = FL 200 GPM 1.70 1.0 300 GPM 3.50 2.10 400 GPM 6.10 3.60 500 GPM 9.30 5.50 600 GPM 13.20 7.80 700 GPM 17.80 10.50 800 GPM 23.10 13.60 900 GPM 29.0 17.10 1000 GPM 35.70 21.0 4 HOSE 5 HOSE 2Q + Q x 0.05 = FL 2Q + Q x 0.03 = FL 200 GPM 0.50 0.30 300 GPM 1.05 0.60 400 GPM 1.80 1.0 500 GPM 2.70 1.60 600 GPM 3.90 2.30 700 GPM 5.20 3.10 800 GPM 6.80 4.0 900 GPM 8.50 5.10 1000 GPM 10.50 6.30 15COURSE STANDARDS FOR CALCULATING ENGINE DISCHARGE PRESSURES NOZZLE OR TIP FLOW PRESSURE NOZZLE FRICTION LOSS PER 100 FEET OF HOSE 1 1 2 3 1 100 GPM 100psi 30 1 150 GPM 100psi 32 2 250GPM 100psi 15 6 1 200 GPM 50psi 10 4.0 1 250 GPM 50psi 15 6.0 1 300 GPM 50psi 21 8.4 1 400 GPM 80psi *36* 14.4 1 500 GPM 80psi 55 22.0 1 600 GPM 80psi 78 *31.2* 1 700 GPM 80psi 105 42.0 1 800 GPM 80psi 136 54.4 1 900 GPM 80psi 171 68.4 2 1000 GPM 80psi 210 84.0 *RED LINE FORMULA FOR ENGINEPRESSURE CALCULATIONS DP = NP + FL + AFL + E Pump Discharge Pressure (DP) = Nozzle Pressure (NP) + Friction Loss (FL) + Appliance Friction Loss (APL) + Elevation (E) Relays maintain 20psi for receiving pumper Hydrant Residual maintain 10psi from hydrant Wyes/Siamese 10psi loss Standpipe Systems 25psi loss Master Stream Devices 20psi loss Elevation 5psi per floor (exclude one floor) or psi per foot 16SUPPLY & SUPPORT OF SPRINKLERS & STANDPIPE SYSTEMSThe following are suggested methods to indicate if youre not getting into a sprinkler or standpipe system with a supply line.A. In warm, humid weather, the lack of condensation on the hose coupling attached to the discharge port supplying this lineB. The discharge port and hose butt supplying this line is or becomes warmC. Lack of a drop in the residual pressure as read on the compound gauge as this line is charged a. Once the supply line is full, there is no further movement of waterD. The inability to gate and feather various pressures on the discharge port to which this line is attached a. The third principle of fluid pressure, Pressure applied to a confined fluid from without is transmitted in all directions without diminution. NOTE: Methods A and B may not be readily apparent or the best indication, especially if the pumper is supplying additional lines which are already flowing.SUPPLYING A STANDPIPE SYSTEM WHEN THE FIRE DEPARTMENT CONNECTION IS NOT USABLEWhen the fire department connection (siamese) supporting a standpipe system is not usable; and the check valve below the fire department connection (siamese) is inoperative, the following procedure should be followed:1. Stretch a line from the pumper to a gated outlet on the first floor2. Remove any house lines, reducer connections and/or pressure reducers3. Connect the pumper supply line to the discharge outlet using a double female adapter4. When the water is started in the supply line, the outlet valve is opened fully to allow water to flow into the riser5. Where the hose outlet extends at a right angle from the riser, the weight of the hose and fittings should be supported by a short length of rope6. If necessary, additional lines can be similarly stretched to hose outlets on other floors When the fire department connection (siamese) has a frozen swivel, placing a double male and double female adapter on the connection can overcome this difficulty. 17SIAMESE OPERATIONSWhen it becomes necessary for a pumper to deliver large quantities of water, a siamese operation will be needed. Siamesing lines is one way of reducing the excessive friction loss created by large volume flows. Though it may look difficult to compute, it is actually no harder than a single line. When it becomes necessary to siamese, divide the GPM by the number of lines that pump is supplying. Next, compute the friction loss for one line at the reduced GPM flow and disregard the other lines. All that remains is to add either the Nozzle Pressure if supplying a deluge gun or 20psi for residual pressure if supplying another engine. EXAMPLE: It is necessary to supply a deluge set with a 1 tip from 400 feet away. This lay would require 800 GPM which would create 55 pounds FL per 100 feet in 3 hose; therefore, siamesing is necessary. EQUAL SIZE LINES 1. Divide the total GPM by two lines. This will five 400 GPM through each line. 2. Compute the friction loss for one line of 3 hose delivering 400 GPM a. 4 x 4 x 2 + 4 = 36 x 0.4 = 14.4 or 15 pounds of FL per 100 feet of hose 3. Multiply the FL for 100 feet by the length of the lay in hundreds of feet a. 15 x 4 = 60psi FL for the total lay 4. Add 80 pounds NP to the 60 pounds FL = 20 pounds approximate loss for the deluge set and this will be the engine discharge pressure a. 60 + 80 + 20 = 160 pounds engine pressure EXAMPLE: If, in the above lay, it was necessary to use a 2 and a 3 line, FL would be computed just a bit differently.UNEQUAL SIZE LINES1. Divide the total GPM by two lines; this will give 400 GPM through each line2. Compute the friction loss for one line of 2 hose delivering 400 GPM a. 4 x 4 x 2 + 4 = 36 pounds FL per 100 feet3. Compute the friction loss for one line of 3 hose delivering 400 GPM a. 4 x 4 x 2 + 4 = 36 x 0.4 = 14.4 or 15 pounds FL per 100 feet of hose4. Add the two FL answers together and divide by two a. 36 + 15 = 51/2 = 14.4 or 15 pounds FL per 100 feet of hose5. Multiply the FL for 100 feet by the length of the lay in hundreds of feet a. 25 x 4 = 100 pounds FL for the total lay6. Add 80 pounds NP to the 100 pounds FL + 20 pounds approximate FL in the deluge set a. 100 + 80 + 20 = 200 pounds engine pressure 18 RULE OF THUMB for siamese of unequal size, but of equal length (2-3) 1-2 & 1-3SIAMESE LINES TOTAL GPM FL PER 100 FEET 500 10 600 15 700 20 800 24 900 30 1000 40 WYE OPERATIONS Wye operations are very common and are used in one way or another on just about any fire of consequence. Sometimes they are used to get 1 hand lines to the fire where the reach is too long for a pre-connect. On most large fires, they are used for overhaul from 2 lines rather than laying longer and/or additional lines of 1. Another use would be to get two 2 lines on a fire from one 3 supply line. Wye operations, like siamese operations are used to reduce friction loss. By the use of a wye, one may have one large supply line feeding two or more smaller hand lines. EXAMPLE: 400 feet of 2 hose wyed to two 200 foot lines of 1 hose.1. Total the GPM from both 1 lines. This is the amount of water for which the supply line must be computed a. 100 GPM + 100 GPM = 200 GPM for both 1 lines b. Therefore, the 2 supply line is flowing 200 GPM2. Compute the friction loss for the supply line a. 2 x 2 x 2 + 2 = 10 pounds FL for 100 feet of hose3. Compute the friction loss for the supply line a. 30 pounds FL per 100 feet = 60 pounds total (disregard the second line)4. 40 pounds FL for the 2 supply line 60 pounds FL for the 1 hand line 100 pounds NP + 10 pounds for the wye 210 pounds Engine Discharge Pressure 19 The lay would give 200 GPM through two 1 lines 600 feet from the engine. The engine would be running at a discharge pressure of 210 pounds. If there were two 1 lines each 600 feet in length, the discharge pressure would be 280psi and the engine would be running at excessive RPM for the job. FRICTIONLOSS CALCULATIONS FOR ELEVATED STREAMS FROM PRE-PIPED WATERWAYSWhen it is necessary to supply a pre-piped waterway, there are some basic facts the FAE will have to know:1. It is necessary to supply the water to the pump inlets or aerial intake when by-passing the pump and supplying the total operation2. It is necessary to know the size tip that is intended for use in order to calculate pressure, determine the number of lines required and their diameter Since the waterways on pre-piped aerials are made of pipe, the following constants are used to determine the friction loss in the piping, master stream at different gallon flows. The friction loss factor for pre-piped waterways will include the friction loss in the:1. Piping2. Turret gun3. Intake at the GMP flow provided For course and testing purposes, the Fire Apparatus Engineer Committee has accepted a standard flow for pre-piped waterway of 1000 GPM. When supplying a pre-piped waterway flowing 1000 GPM, a friction loss of 60psi will be used; which includes the intake, piping and master stream device. When pumping directly to the waterway, an additional 20psi will be added for the friction loss in the direct piping. Departments are encouraged to flow test their own apparatus to determine the actual friction loss.There are four ways to supply a pre-piped waterway: 1. Ladder truck pumps through internal piping to the ladder2. Ladder truck pumps through hose into the ladder intake3. Engine company pumps into the ladder intake4. Relay to ladder truck pump operator (refer to relay operations) 20 EXAMPLE 1: It is necessary to supply a pre-piped aerial ladder.The aerial is elevated 50 feet above grade on a 100 foot aerial with a 2 tip (1000 GPM). The FAE decides to use two 100 foot lengths of 3 hose as feeder lines to supply the aerials siamese in the rear of the aerial. Each of the lines will carry 500 GPM and the friction loss in the feeder lines will be about 22 pounds for the 100 foot lay.The constant is 60psi friction loss on a 100 foot pre-piped aerial ladder intake connection and master stream device. Obtain the engine pressure and add as follows: 22psi loss for two 100 foot lengths of 3 feeder line 60psi loss for 100 foot pre-piped aerial, intake and master stream 25psi loss for elevation + 80psi loss for nozzle pressure 187psi will be the Engine Discharge PressureEXAMPLE 2: Using the same pre-piped aerial ladder as Example 1, except this time the FAE will use the piping form the pump to the aerial: 60psi loss for 100 foot pre-piped aerial, intake and master stream 20psi loss for piping from the pump to the base of the aerial ladder 25psi loss for elevation + 80psi loss for nozzle pressure 185psi will be the Engine Discharge Pressure The examples given above have been figured with 60psi friction loss in the piping of a 100 foot aerial ladder flowing 1000 GPM as a standard.All students having aerial devices shall utilize the manufacturers specified friction loss in their departments pre-piped aerials. 21ELEVATED STREAM MISCELLANEOUS NOTESThe following are some recommended procedures for obtaining good elevated streams:1. Try to keep supply lines under 300 feet 2. Nozzle pressure should be 80psi for solid streams and 100psi for fog streams For each foot of elevation, the weight of water produces a pressure of 0.434 pounds per square inch. This may be rounded off to 0.5 pounds per foot of elevation for fire ground calculations. Consider the simple basics, good elevated streams are possible if:1. The proper size tip or fog nozzle is used for the available water supply and pumping capacity2. Sufficient lines of sufficient diameter are run from the pumper to the base of the elevated apparatus3. Sufficient pressure is maintained The modern aerial ladder is a valuable piece of equipment of the department that uses it well. Yet, if used incorrectly, firefighters can be seriously endangered; maintenance costs needlessly high; and fire losses increased. Careful study, supervised training and constant practice are needed to bring the engineers skill to the highest point of efficiency. 22GENERAL OPERATING SUGGESTIONS FOR CENTRIFUGAL FIRE PUMPSA centrifugal pump is designed for a specific duty and ordinarily will perform this duty satisfactorily over a long period of time. On occasion however, trouble will show up in one form or another and even an experienced operator may have difficulty in locating and correcting it. The suggestions listed below should be helpful.IF THE PUMP WILL NOT PRIME OR LOSES PRIME 1. Air leaks a. Faulty connection i. Suction hose or gasket ii. Discharge valves or gaskets iii. Booster tank iv. Drain valves v. Gauge b. Faulty pump packing c. Leaky pump gaskets All suction hose gaskets should be wiped clean of sand, pebbles and any other foreign matter before hose is attached to the pump.Hose couplings should be tightened snugly enough to make air-tight connections. Main pump packing should always be kept adjusted tightly enough to prevent excessive leakage (see manufacturers operating instructions for proper packing adjustment procedure).2. Detecting air leaks a. Connect suction hose to the pump with a cap on the opposite end of the hose b. Close all pump openings c. Open the priming valve and operate the primer until vacuum of 20-22 inches of mercury is shown on the vacuum gauge i. If it is impossible to draw this much vacuum, the primer may be defective d. Close the priming valve and shut off the primer e. Shut off the engine i. If leaks are present:1. The vacuum will promptly decrease as shown by the vacuum gauge2. If the vacuum drops more than 10 inches of mercury in five minutes3. Locating air leaks Air leaks may frequently be detected by ear if the engine is stopped. Applying water or oil to the suspected points may aid in detecting leaks. Leaks may be found by applying water pressure to the pump and suction hose by means of an auxiliary pump or hydrant. Pressures should be approximately 50psi and should not exceed that recommended for the suction hose or pump. 23 a. Dirt in the suction screens i. Dirt-clogged suction screens may make it difficult to prime the pump, as well as cause the pump to lose its prime after it is started ii. When operating from a draft, be sure suction screens are kept clean1. Be sure to keep the end of the suction hose off the lake or river bottom2. For this purpose, a special box or basket, which fits around the suction strainer or is threaded to the end of the hose, is frequently fabricated b. Engine speed too low i. Follow the manufacturers recommendation for priming ii. Speeds higher than those recommended do not accelerate priming c. Primer not operated long enough i. Follow the manufacturers recommendation ii. The maximum time for priming for lifts of 10 to 15 feet should not exceed 30 seconds for 1250 GPM pumps or below; or 45 seconds for 1500 GPM pumps or above d. Lack of oil in the primer reservoir i. Where a mechanically driven or electrically driven rotary primer is in use, an adequate supply of oil should always be kept in the reservoir to lubricate and seal the priming pump e. Improper clearance in rotary primer i. Due to wear, the clearance between the priming pump rotors and head may become so large as to cause poor priming characteristics1. In this case, the proper clearance should be restored by the method outlined by the manufacturer in the priming pump operating instructions f. Excess carbon on exhaust primer valve seats i. See exhaust primer manufacturers operating instructions to remove carbon g. Defective priming valve i. A broken or deteriorated priming valve spring may cause the valve to leak and the pump to lose its prime. ii. Worn parts in the priming valve may also allow air leakage h. High point in suction line i. High points in the suction line (caused, for example, by running suction hose over a bridge railing) create air pockets which may case loss of prime ii. In some cases, it may be impossible to rearrange the suction hose to eliminate the high point1. In this case, prime may be obtained by closing the discharge valve immediately when the pressure drops and then re-priming2. This procedure usually eliminates the air pocket which was drawn into the impellers when the pump was started after first priming; however, it may have to be repeated in some situations 24 i. Suction lift too high i. Lifts of more than 20 feet should not be attempted, even at low altitudes, unless there are practically no air leaks and the equipment is in new condition1. In this case, higher lifts may be obtained j. End of suction hose not under water i. The end of the hose may be submerged enough for priming, but when a large volume of water is pumped, a whirlpool is sometimes formed which uncovers the end of the hoseIF PUMP WILL NOT DELIVER CAPACITYThe following may prevent the pump from delivering its rated capacity:1. Relief valve improperly set a. If a relief valve is set at a pressure below the desired operating pressure it will bypass water and lower the capacity (see manufacturers relief valve operating instructions)2. Badly worn wear rings a. Failure of the pump to deliver its rated capacity at a given pressure may be an indication that the impeller war rings are badly worn, allowing excessive quantities of water to leak around them3. Suction screen and impeller vanes fouled with debris a. Backwash of water from the pump through the impellers when the pump is stopped usually cleans the impeller vanes i. Debris on the pump suction screen however, usually remains in the suction hose and is immediately caught by the screen when pumping is resumed ii. Therefore, the suction hose should be removed and cleaned4. Chassis transmission in wrong gear a. See operating instructions5. Suction hose has collapsed a. On defective or old suction hoses, the inner liner often collapses when drafting water, thus restricting the flow of water to the pump b. Collapse of the inner liner is often hard to detect even when the inside of the hose is examined with a light i. This is due to the fact that the inner liner often goes back in place when the suction vacuum is removed ii. If the pump will deliver capacity with a different suction hose, it is reasonable to assume the liner on the former hose has become loosened6. Suction hose not submerged deeply enough a. The lower end of the suction hose should be submerged at least two feet below the surface of the water to avoid taking in air 257. Suction hose too small a. When higher than normal lifts are involved or at high altitudes, larger hose is needed8. Insufficient engine power a. Although the engine had sufficient power originally, there are several reasons why the power can decrease to the point at which it will not handle the pump at the rated capacity and pressure b. Things to suspect are: i. Incorrect timing ii. Fouled spark plugs iii. Burned distributor points iv. Weak condenser or coil v. Sticking valves vi. Worn piston rings vii. Worn fuel pump poor carbonation c. Also, if the engine is operated at higher than normal altitudes, the power may be too low i. The power of an engine decreases about 3-4% for every 1000 feet of increase in altitude d. Excessive engine temperatures, which frequently occur in hot weather and during long periods of operation reduce the power i. This can be caused by:1. Clogged radiator or heat exchanger2. Insufficient coolant3. Worn water pump4. Loose fan belt5. Deteriorated crank case oil e. Transfer valve improperly set i. Does not apply to single stage pumps ii. The valve should be in a parallel (volume) position when pumping more than one half of the rated capacity iii. When changing the position of the valve, make sure it is moved completely into the new position; if not, the pump performance may be seriously affected 26IF PUMP WILL NOT DEVELOP SUFFICIENT PRESSUREIn general, conditions which prevent the pump from delivering the rated capacity will also affect the pressure adversely. The following may prevent the pump from developing sufficient pressure:1. Relief valve improperly set a. A relief valve properly set will prevent the pump pressure from rising much above that at which it is set i. Consequently, too low a setting causes too low a pressure ii. See manufacturers relief valve operating instructions2. Insufficient pump speed a. May be due to one or more of the following: i. Impeller wear rings or other pump parts binding ii. Clutch slippage iii. Chassis transmission in wrong gear iv. Governor limiting engine speed v. Insufficient engine power3. Transfer valve improperly set a. Does not apply to singe stage pumps b. The transfer valve should be in series (pressure) when pumping at high pressures4. Capacity limiting pressure a. Care should be taken not to attempt to take more water from the pump than it can handle at the desired pressure (see instructions on operation of pump) b. If the pump is operating at draft under normal suction conditions and the maximum rated capacity is exceeded the pressure will be low due to the characteristic of a centrifugal pump even if the engine has plenty of power and speed c. Excess capacity may raise the suction vacuum to a point above that which the pump was designed and lowered pressures will result d. On pumping units having engines with low surplus power, the pressure will be limited by engine power if surplus capacity is being pumped 27AUTOMATIC PUMP PRESSURE CONTROLLERThe automatic pump pressure controller is a device which regulates the engine speed of a pumper to preclude surges or drops in the pressure of operating discharge lines as other lines are closed or opened.The basic method by which the device works is to compare the pump discharge pressure to a reference pressure stored, when the pump is set into operation, in a device called an accumulator.As pump discharge pressure varies in response to changing discharge volumes, the reference pressure in the accumulator acts on a hydraulic cylinder which in turn actuates a rod connected to the throttle linkage thereby adjusting the engine speed.The operating range of most automatic pump pressure controllers is between 75-500 pounds. If the pump pressure drops below 30 pounds per square inch, the unit automatically disengages, thus protecting the engine as in the case of loss of prime. This device is equally effective with gasoline or diesel engines. Home Solutions