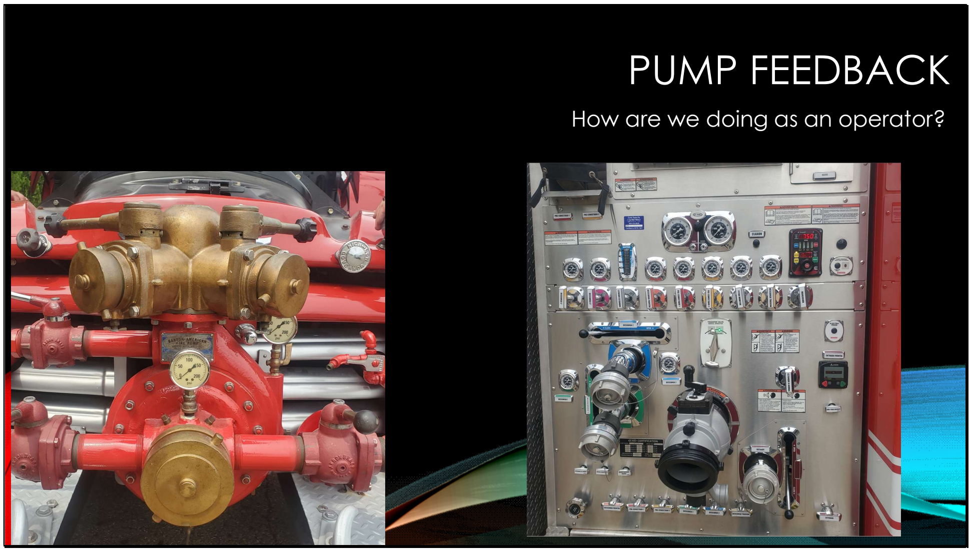

DON'T TOUCH THE RED BUTTON
Understanding the Ins and Outs of Pump Controls

Mundane things to excite the average individual, they find these things lacking in interest, excitement or just plain dull. It takes a special individual to find excitement in what others find mundane, things like gauges and pressure transmitters. By having a passion for things others find mundane, you will be able to excel and set yourself apart. Thank you for taking this journey.

Feedback tells the controls how the process is operating. Looking at things providing the operator feedback first gives a solid foundation about the data needed for operation. As it is said about computers, say garbage in garbage out. Operators must understand the feedback systems and know if they are providing realistic values.

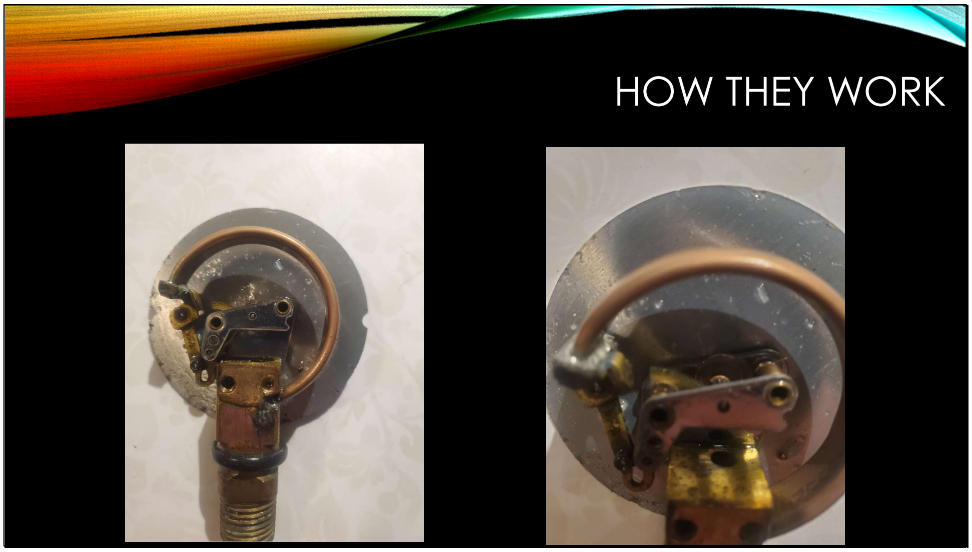

NATIONAL FIRE PROTECTION ASSOCIATION
The leading information and knowledge resource on fire, electrical and related hazards
NFPA
• NFPA 1900 Standard for Aircraft Rescue and Firefighting Vehicles, Automotive fire Apparatus, Wildland Fire Apparatus and Automotive Ambulance, 2024
• NFPA 1910 Standard for the Inspection, Maintenance, Refurbishment, Testing, and Retirement of In-Service Emergency Vehicles and Marine Firefighting Vessels, 2024
• NFPA 1962 Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances, 2018

Human can process more inputs, sound, smells, feel, sight than a computer.
A computer bounded by programed logic and limited inputs – RPM and pressure. It reacts based on the information received and does not discern is the data makes logical scene.



The pump panel has definitely evolved over the years, from a single input and output gauge to multiple gauges and displays provided a wealth of information to the operator.

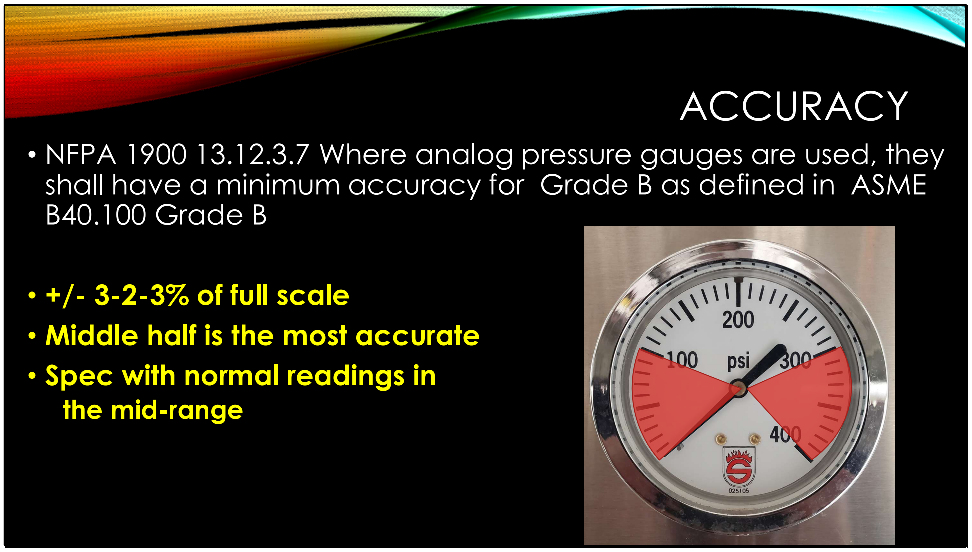
The pressure gauge is the primary feedback mechanism for the pump operator.



The Bourbon tube pressure gauge was invented by the French Scientist Eugene Bourbon in 1849. It consist of a C shaped tube, linkages, gears, and pointer. The tube when pressure enters, the amount of deflection is based on the material and construction of the tube. The deflection of the tube then pulls the linkage which turns the gears connected to the pointer. Once the tube is damaged, from freezing for example, the gauge will not return to its original condition.

Reference: https://blog.wika.us/products/pressure-products/eugene-bourdon-history-bourdon-gauge/

The maximum pressure a gauge is calibrated to read is the range or span.
The ranges normally seen on fire service gauges are 0-600 and 0-400 in discharge gauges and 30inHg -600 or 30inHg -400 in compound gauges.



For a 0-400 gauge having this accuracy, the mid-range of 100 to 300 psi has an accuracy of +/- 8 psi with the first and second quarters (0-100 & 300-400) having +/-12psi.
For a 0-600 psi gauge the mid-range of 150 to 450 psi has an accuracy of +/- 12 psi and the first and second quarters (0-150 & 450-600) an accuracy of +/-18psi.
How are the accuracy of our readings impacted by the pump discharge pressure needed for current hose and nozzle combinations? With 1 ½" hose and 100psi fog nozzles, pump discharge pressures over 150psi were common. With today's low friction hose and 50psi nozzle combinations it is possible to have required pump discharge pressures below 150psi. When upgrading hose and nozzle packages take the time to determine if the current pump panel gages will provide the best readings possible. What is the impact of over pumping the package by 20psi if the pump discharge pressure is below 150psi and the gauge range is 0-600?

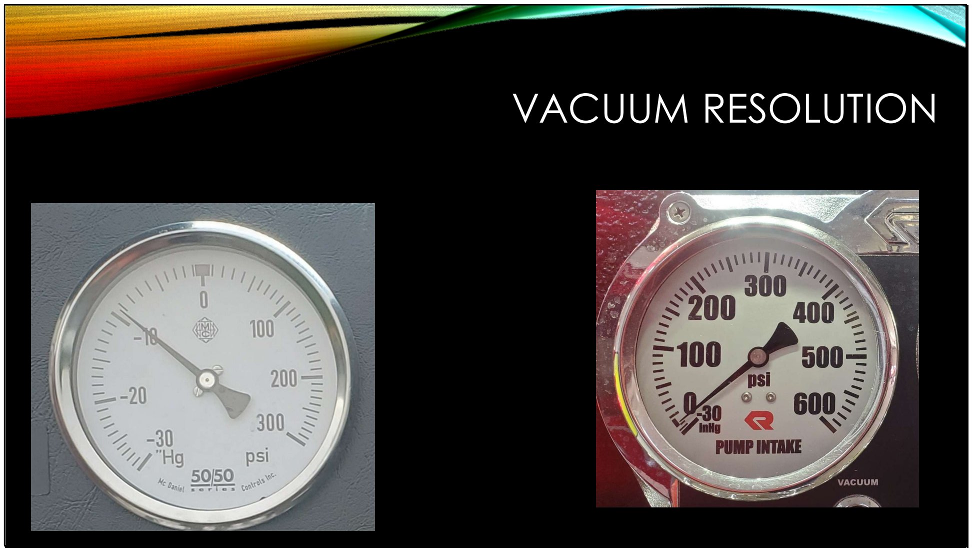
How often do you test your gauges?

NFPA 1910 22.7.10.1 states all gauges shall be tested at 150, 200, and 250psi annually. NFPA 1910 22.7.10.2 states if a gauge is off by over 10psi it must be replaced. If the range of the gauge is 0-600 psi, the standard for the gauge is 2% or 12psi. Based on this it would be possible for a brand new gauge to be within tolerance but require replacement. For this reason have all gauges checked on new apparatus to make sure they meet or exceed the minimum standard. While NFPA provides three pressure points to calibrate the gauges, it is a good practice to include the pressure most used as the pump discharge pressure, for example the primary pre-connect lines.

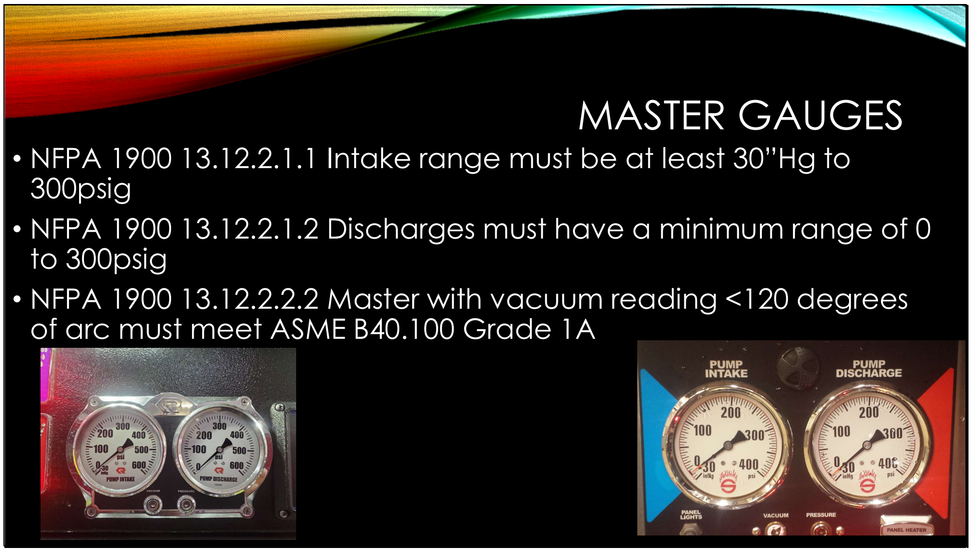
What other gauges might need tested? Standpipe gauges are bounced around in the engine on every run. It is a good practice to include these in your annual checks.

Resolution the smallest value a pressure gauge and measure and display. This is important in digital transducers as well. The primary division on gauges is normally 100psi increments, this is required by NFPA 1900 15.12.2.2.6. The secondary division can be 10 or 5 psi. Ten is more common especially on 600psi range gauge because there just is not enough room to make 5psi secondary divisions on the individual discharge gauges. A resolution of 10psi is the minimum set by NFPA 1900 15.12.2.2.6. Going to a 400psi range allows finer resolution and greater accuracy in the range for modern hose and nozzle combinations.

Reference: https://www.dwyeromega.com/en-us/resources/pressure-transducer-specs

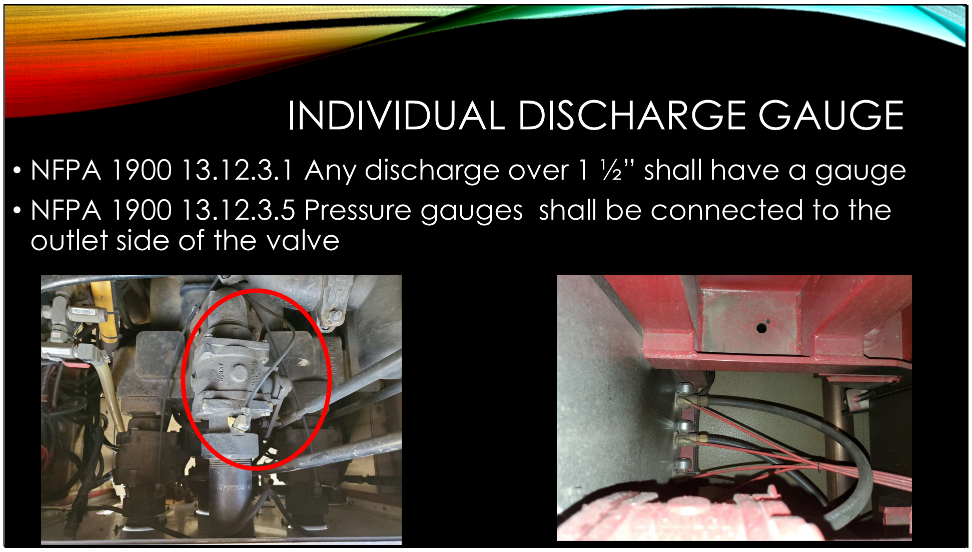


Most pumps have a compound gauge with limited resolution. If a department conducts drafting operations frequently consider a gauge with a better resolution or a transducer with a digital readout.



The master discharge reads at the pump discharge before any of the valves, the tapping point is often at the discharge flange. The master intake reading is taken after the intake valves on the intake flange of the pump.

Grade 1A is +/- 1% over the span of the gauge, minimum accuracy +/-3psi for a range of 300psi, 400 = +/- 4 psi, and 600 = 6+/- psi.



Pump-to-tank discharges normally do not have gauges. The pressure limit for filling poly tanks is 100psi. This is a reason not to fully open the tank fill valve when the pump discharge pressure is over 100psi.

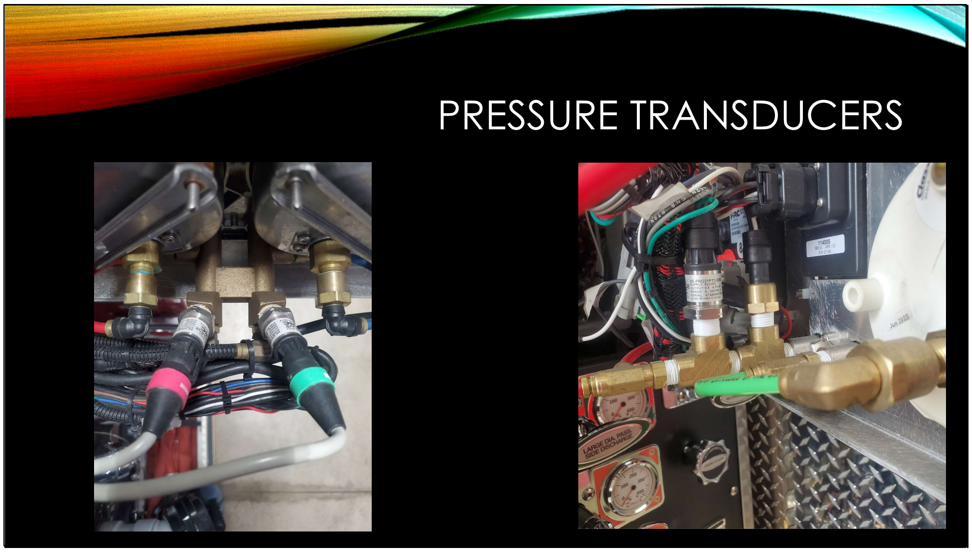
The distance of the tap from the valve will impact the accuracy of the reading. If there are bends and diameter changes after the gauge tap point the reading will be higher than if it was at the point of discharge. These pressure loses are not taken into account when discharge pressure are only calculated using nozzle pressure and friction loss.

When the valve is gated, turbulence and increased velocity will impact the pressure reading unless the tap point is at the discharge or a minimum of 4 diameters from the valve.

Gauges are being tapped at the top of the drain valves. With the drains being the lowest point in the system, sediment and debris can accumulate and impact the pressure readings. It is important to flush the drains on a regular basis to prevent gauge lines from becoming plugged.

Main takeaway: Understand the location of the gauge tap point and how it will impact the pressure reading.

Company 18 in Santiago Chile has a tank to pump pressure gauge. This is the only one I have seen.

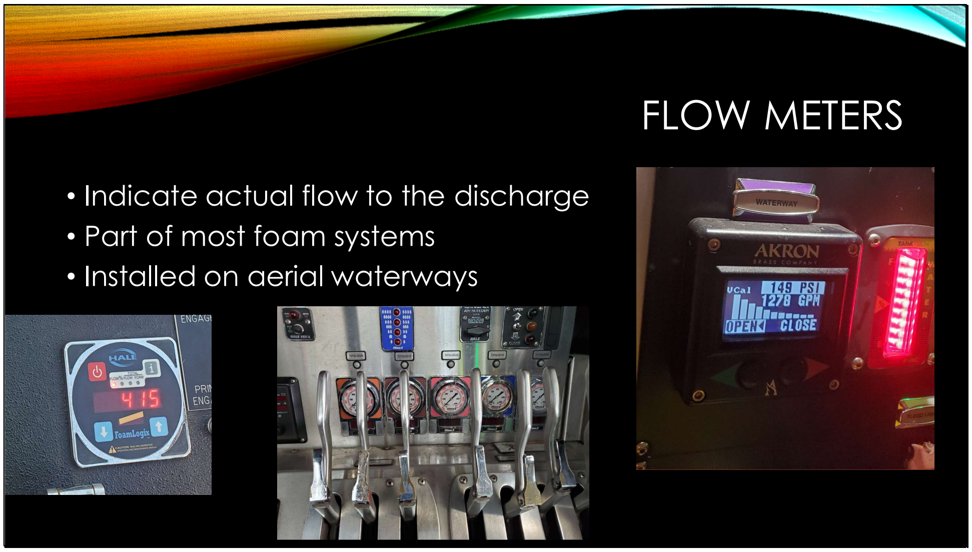


Transducers provide an electrical signal, usually 4-20mA, proportional to a calibrated pressure range. This is done by strain gauge on a diaphragm.

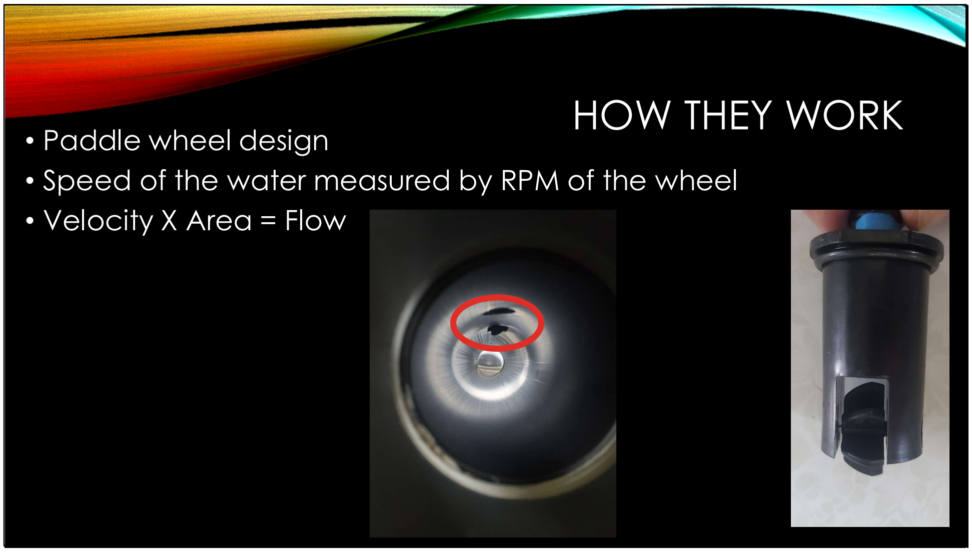
Transducers allow for pressure governors and digital pressure displays with greater resolution to be used on modern apparatus. Installation can be remote without fear of pressure gauge lines freezing or trapping a large amount of air.

NFPA 1900-15.12.2.3.2 Digital pressure gauges shall display pressure in increments of not more than 10psi.
NFPA 1900-15.12.2.3.3 Digital master pressure gauges shall have an accuracy of +/-3% over the full scale.
NFPA 1900-15.12.3.8.2 Digital pressure gauges shall display pressure in increments of not more than 10psi.
NFPA 1900-15.12.3.8.3 Digital pressure gauges shall have an accuracy of +/-3% over the full scale.

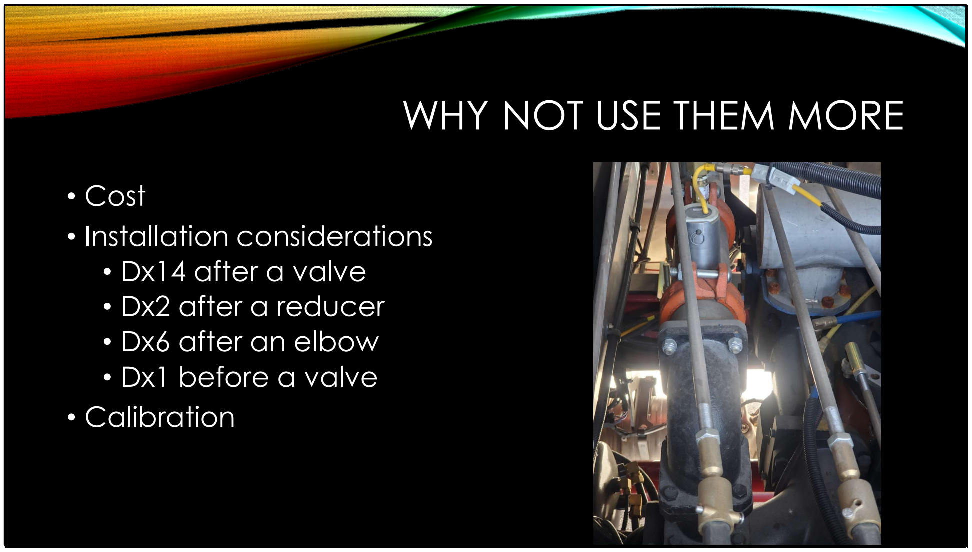
References:
https://www.youtube.com/watch?v=k8xMuqvKnyU&list=PLllVXVuEhX9jg03Q38Bqhq8--bwqbi3t1&index=2



Flowmeters take the guess work out of flowing lines.
Per NFPA 1900 12.3.2 all discharges with a flowmeter must have a pressure gauge as well since flow can be made at different pressures depending on the system resistance. Less resistance, like a burst line, requires less pressure to generate the flow. Kinks or partially closed valves require higher pressure for a given flow.
Readings can be greatly influenced by sensor position.



Speed near the wall is slower than the middle but calibration accounts for this. If flowmeters are not calibrated annually accuracy can be lost.



Why doesn't every engine have these at least on the primary discharges? Initial cost often makes it difficult to justify installation.
Flow meters should be calibrated every year adding to the overall cost of ownership.
The plumbing impacts the flow significantly making it difficult to have an installation point to get the most accurate reading.

For 2 ½" plumbing flow meters should be:
Dx14 =35" after a valve
Dx2 =5" after a reducer
Dx6 = 15" after an elbow

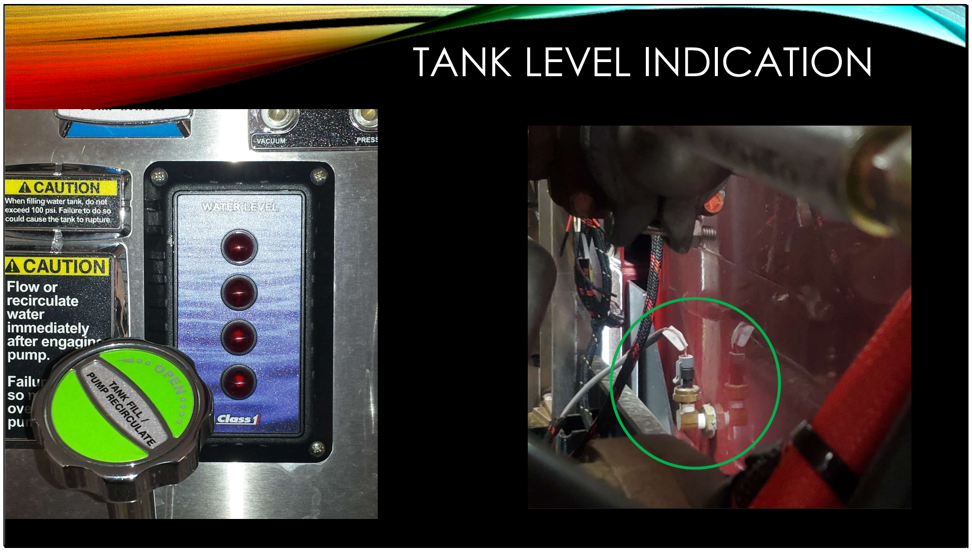
NFPA CONSIDERATION

- NFPA 1900 13.12.3.9 Each flowmeter shall be calibrated to an accuracy +/- 5 percent when flowing the amount of water shown in Table 13.12.3.9
- NFPA 1900 13.12.3.2 Any discharge with a flow meter shall also be provided with a pressure gauge

1900 13.12.3.9	
Discharge size	Flow (GPM)
1 ½	90
2	160
2 ½	250
3	375
4	625

Either through a flowmeter or discharge pressure corelated to a specific flow, the operator can "see" what is happening on the fire ground. It is important for the operator to understand the correct pressure required to flow each line in operation.

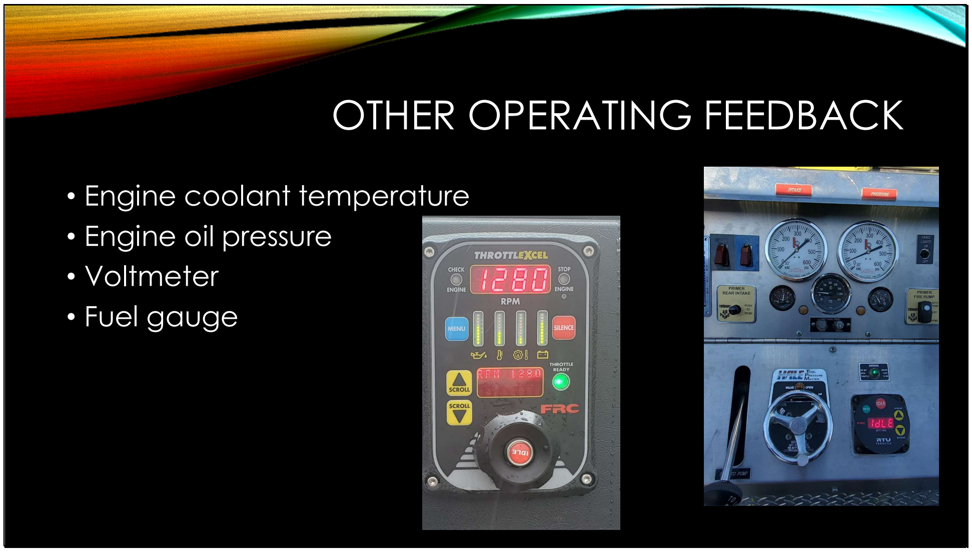
If the pump develops issues it often will require more RPM, engine power, to create the same flow and pressure.
Annual testing helps to compare pump performance over time.



Most level gauges use a pressure transmitter at the base of the tank to determine the level by the pressure head.

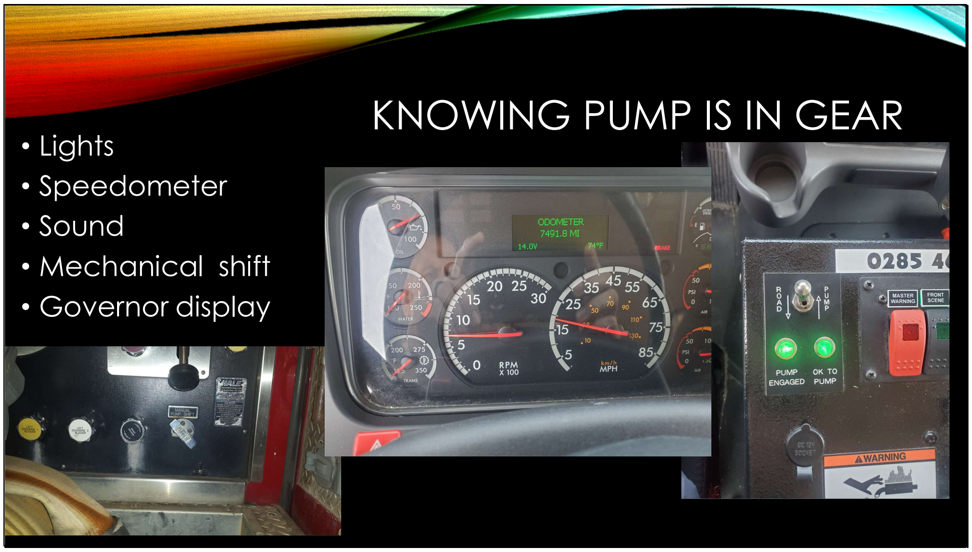
Knowing the time to empty for the normally used lines gives the operator a backup should the pump level indication fail.

The best practice to check tank level during truck checks is to open the tank vent to see the level of water in the tank.



Engine coolant and oil pressure must have an audible alarm per NFPA.
Know what these alarms sound like before they go off.
The fuel gauge is not required.
These items and more are now provided in the pressure governors.

For any system, stopping in the center, neutral position, allows the power train to unload making for smoother transfer between road and pump and vise a versa.
If you have a mechanical override system, make sure you work with it before you need it on the fire ground because the main system has failed. These systems must be exercised to prevent freezing up due to dirt and road grim. Follow proper maintenance and operating procedures for the system. Most require the system transfer system to be in the neutral position but then placed in the pump position after mechanically engaging the pump. This signals the transmission computer to pump in the proper gear. In most cases the transmission will stay in first gear if the primary system is left in neutral.


KNOWING PUMP IS IN GEAR
• Lights
• Speedometer
• Sound
• Mechanical shift
• Governor display
ODOMETER
7491.8 MI
RPM
X 100
MPH
PUMP ENGAGED
OK TO PUMP
ROAD
PUMP
0285
WARNING

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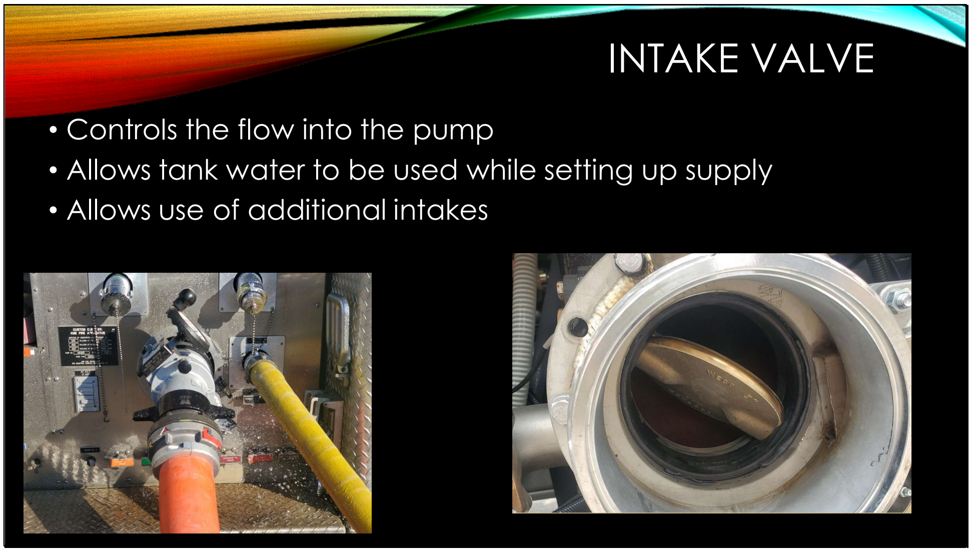
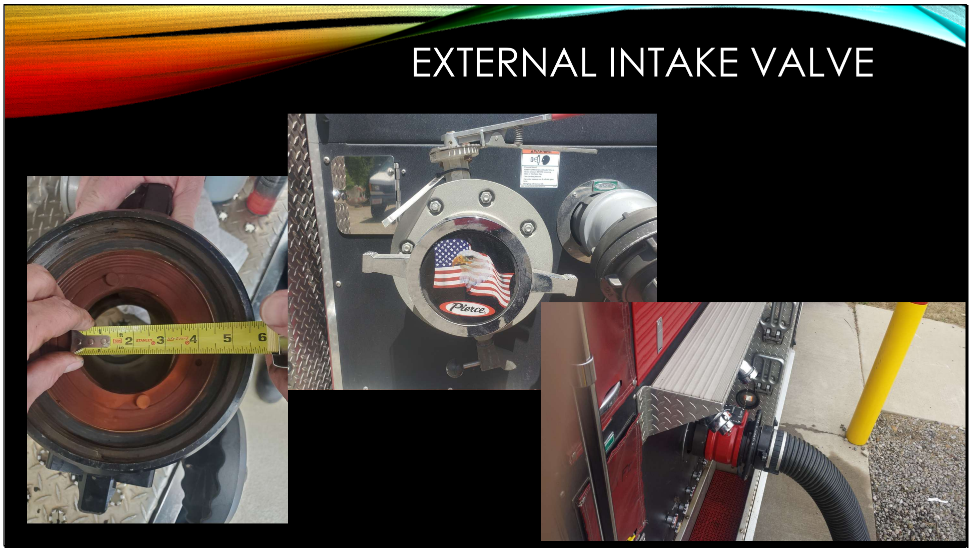
Slide 28



Intake valves can be external to the pump intake or integrated into the intake piping. Compared to a capped intake, a valve allows flexibility to add water supplies from external sources without compromising the flow from the tank.

Main takeaway: Intake valves provide flexibility in water supply.

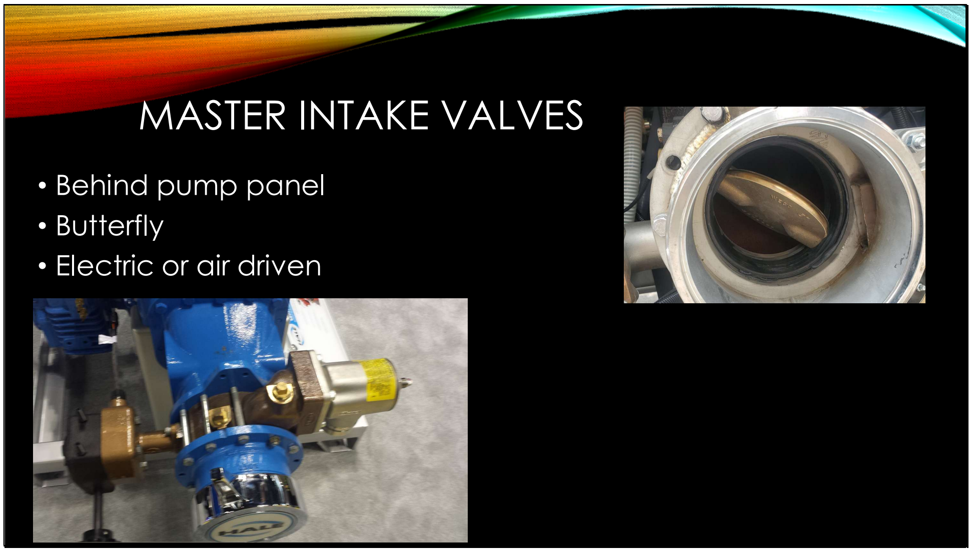


External intake valves have waterways smaller than the 6 inches intake piping.
The main styles of intake valves are piston, butterfly and ball intake valves (BIV). Piston valves, and ball intake valves are external to the pump intake plumbing. Butterfly valves can be external or integrated into the intake plumbing.
A piston style valve uses a piston which slides through the water way to restrict the passage of water. Due to the large surface area between the sliding piston and the valve housing, binding due to deposits is a common occurrence. These valves should be exercised on a regular basis to keep the piston moving freely.
A ball intake valve is a quarter turn ball valve using a quarter of a sphere as the valve to limit size, weight, and contact with non-moving parts.
Both styles of external intake valves incorporate pressure relief valve and bleed valve.
External butterfly valves (center picture) are normally dedicated to drafting operations. These valves provide a full-size waterway with limited restriction from the butterfly plate when it is opened. Compared to an internal butterfly, the external butterflies are more economical and easier to repair. A pressure relief valve is not incorporated into external butterfly valves as the intake is normally used for drafting. Many departments with static and pressurized water sources will set one side of the apparatus up with a ball or piston intake for pressurized sources and the other side with a butterfly valve for drafting.

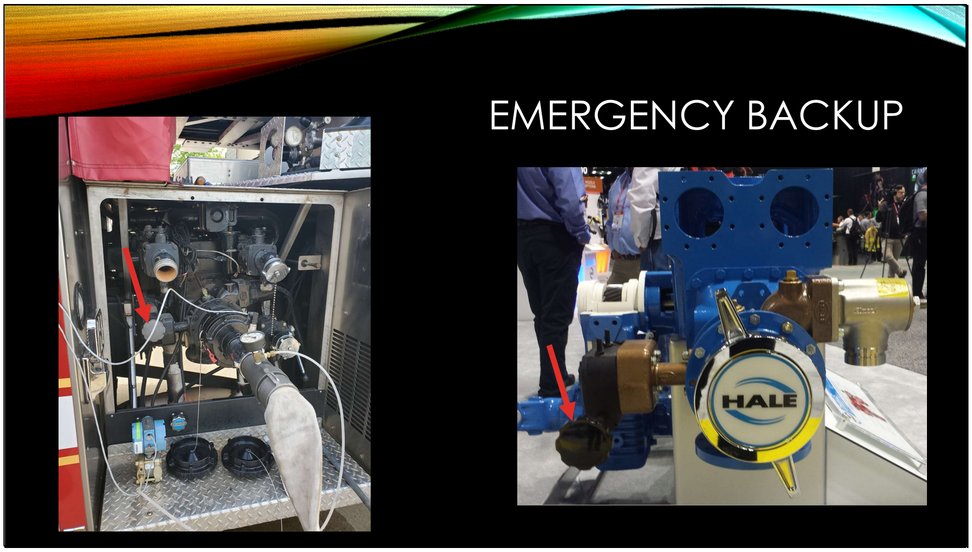
The picture on the left shows a BIV with a 3 5/8" waterway. This will restrict the ability of the pump to generate maximum capacity. There are BIVs on the market with large waterways capable of flowing the rated capacity of the pump.   Make sure what is added to the intake does not reduce the capacity of the pump.

It is possible to draft through a BIV but it is important to test the maximum capacity of the pump through the BIV. If Storz connections are used at least on side, usually the suction hose side, should have a drafting gasket.

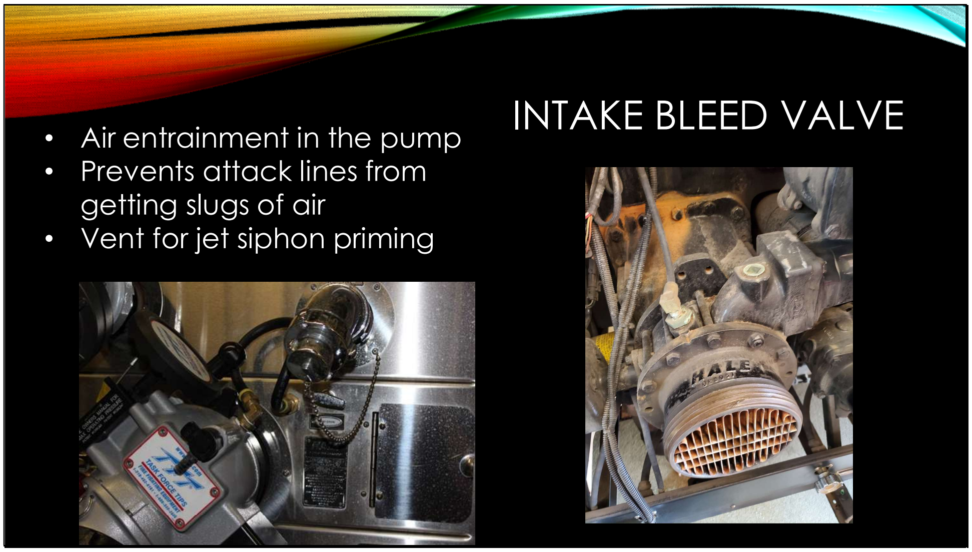
Main takeaway: The intake valve may restrict flow, understand the intake on the apparatus and how it may impact operations.



Master intake valves are butterfly style valves the same size as the intake waterway. The valve is operated by electric motors or air actuators.
The butterfly plate seals against a rubber gasket. It is important to exercise the valves to prevent the plate from sticking to the gasket preventing the valve from opening. If this happens, the manual override system can be used to apply greater torque to break the plate from the gasket.



Most MIVs have a manual operating system to use if the electric motor fails or the valve gets stuck.

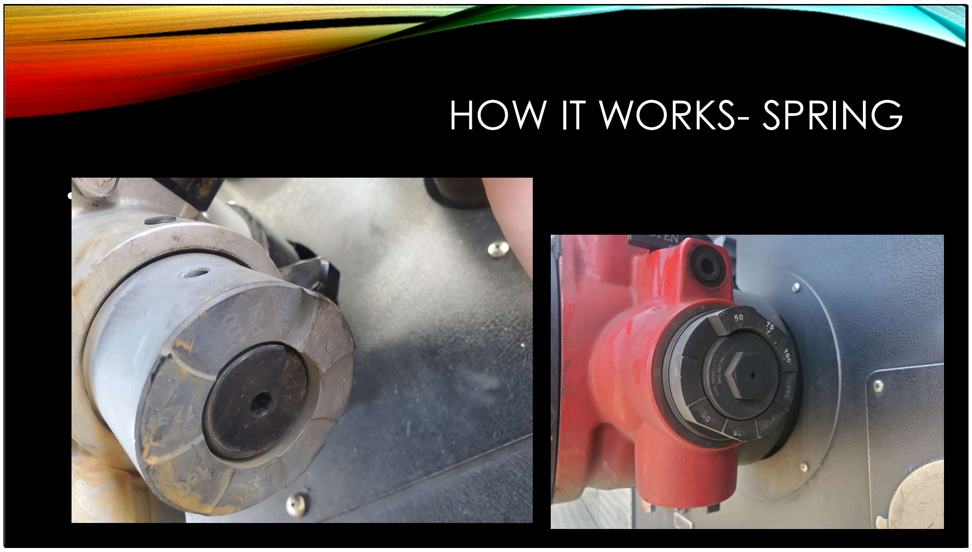


NFPA 1900 13.6.5 Every valved intake shall be equipped with a bleeder valve.
Centrifugal pump not able to move air. Air entrained in the intake result in a drop in discharge pressure as the air travels through the pump. This drop in the discharge pressure tricks the pressure governor into low water mode momentarily. Once the air is passed and a solid flow of water is reestablished the governor will return to normal operation.
Main takeaway: Centrifugal pumps cannot move air, it is important to bleed the air out before the inlet is opened.

Intake pressure relief valves are located in two places along the intake, before each large intake valve and on the intake manifold.

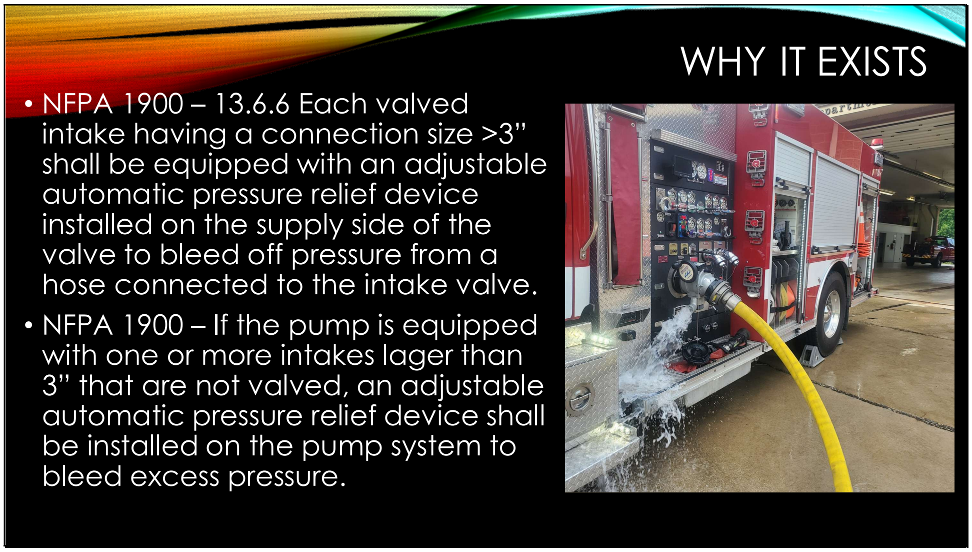
Do not cap the discharge of the relief valves. Threads are there to connect a hose to get water away when setting or if a leak in the valve prevents pulling a draft.

Main takeaway: Know where the intake relief valves are located.

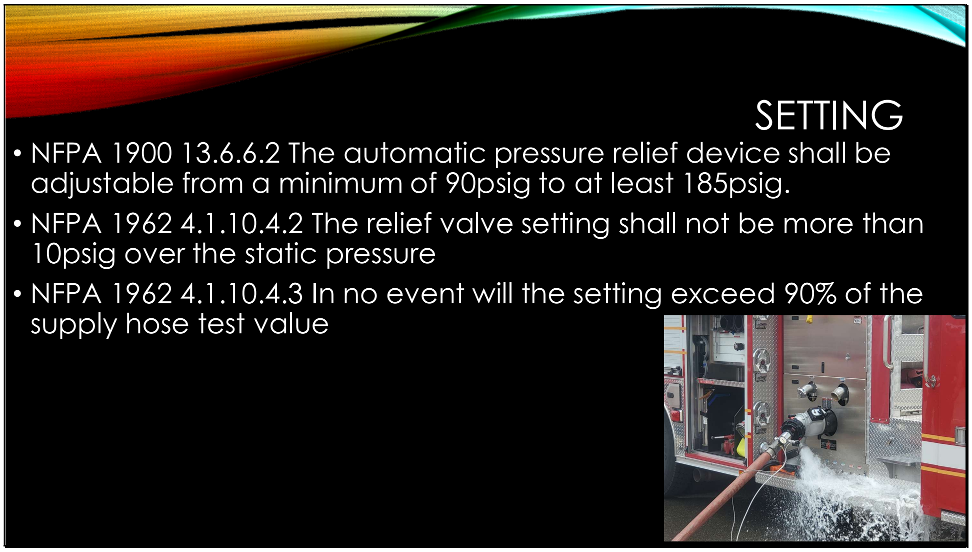


Most intake relief valves operate with a spring holding a valve to a seat. When the force on the valve is greater than the force of the spring the valve will open relieving the pressure. Turning the adjustment nut down increases the compression of the spring and the force exerted on the valve requiring higher pressures for it to open.

This style uses a spring and air to operate the valve. The spring helps return the valve to position and provides a level of backup should the seal become damaged and air leaks past. Air pressure is the primary force to hold the valve closed. The panel gauge allows the operator to know the pressure setting of the relief valve. An advantage of this style of relief valve is the ability to accurately and easily set it without tools or gauges.

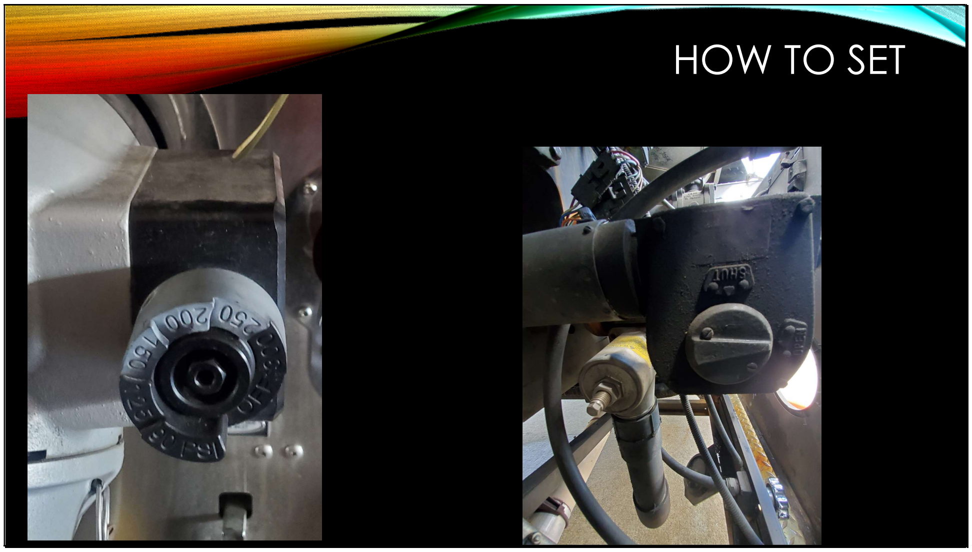


The primary purpose of the intake relief is to protect supply line and plumbing.
A secondary purpose is to limit pressure spikes to the pump.



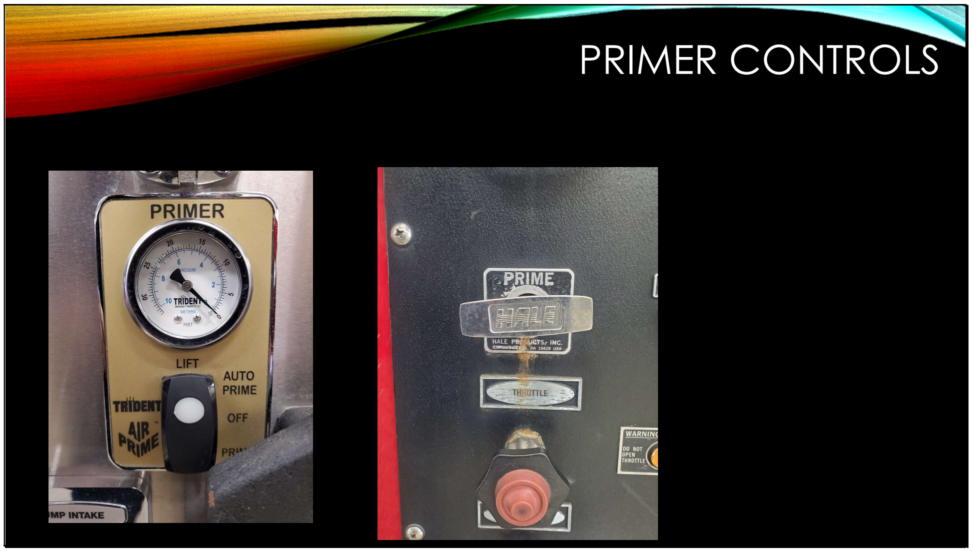
The most useful method is to set the pressure 10psi above the highest pressure in the response district or 90% of the supply hose test pressure.
200 psi test pressure – 180psi setting
250 psi test pressure – 225psi setting
Relief valves may need reset for high rise operation if two or more engines are used to boost the pressure to the FDC. In this case special high-pressure hose is needed and special intake fittings.
The common setting from the factory is 125 psi.
Relief valves should be tested once a year at a minimum. This test allows verification of the opening pressure and exercises the valve to ensure it opens and closes properly.

Main takeaway: The +10psi setting may be impractical with a large range of hydrant pressure. The 90% of supply hose test pressure setting is often more practical. Intakes must be tested on a regular basis.



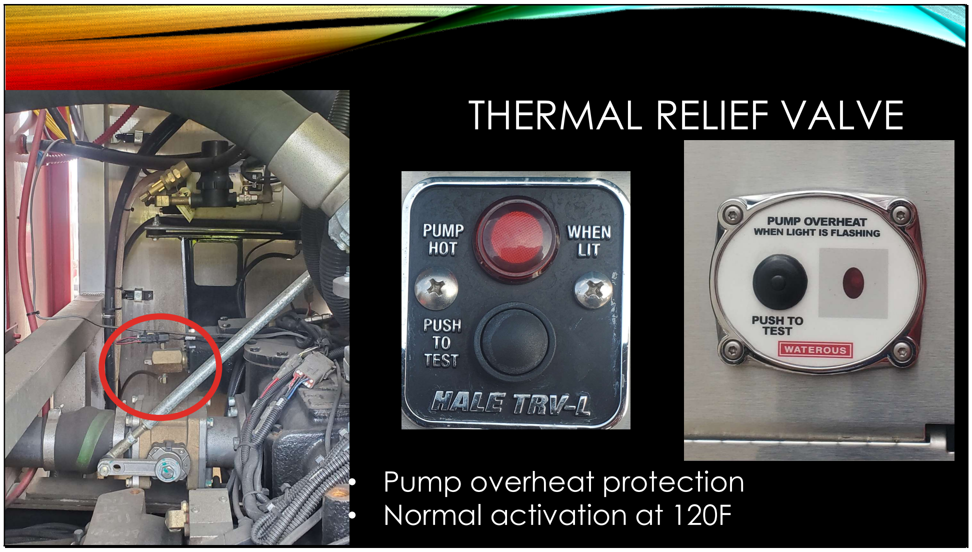
Some styles of relief valve have a stepped ring on the outside of the stem marked with pressure values, when the stem is aligned with the step the valve is set for approximately that pressure. The other style of relief valve is an adjustable stem and lock nut. This style requires a pressure gauge to know the opening pressure of the valve when setting.
Have the tools needed to adjust the pressure relief valve on the apparatus and assessable to the operator.
The internal valves may be challenging to adjust in the field due to location.

Main takeaway: Have the tools and knowledge to adjust the intake relief is needed.



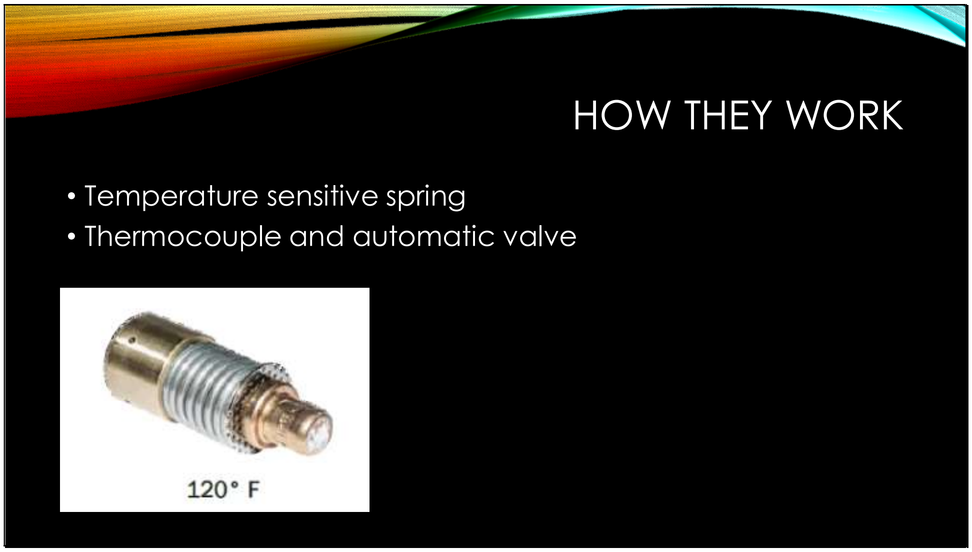
Two different types of primers are predominantly found in the US fire apparatus market, air and positive displacement pumps. The positive displacement pump is driven by an electric motor. Priming time should be limited to 30 to 45 seconds to prevent the motor from overheating. If the actuator is a pull handle make sure to exercise it at least once a week. There have been instances where the primer handle would not pull out preventing the primer from being used to drafting.

The air primer used air from the apparatus' brake system to create a negative pressure in the pump cavity through the venturi effect. If an apparatus has an Auto primer, leave the primer in the auto position. When the pump is engaged it will operate the primer until 20psi discharge pressure is achieved. Should the discharge pressure drop below 20psi the primer will engage automatically.

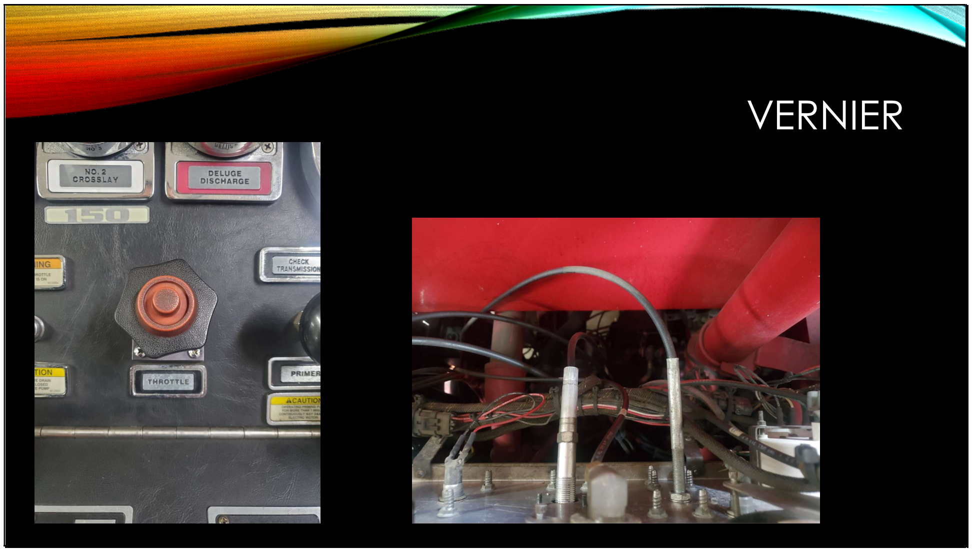


Thermal relief valves use a temperature reactive spring which opens at 120F. Hard water can cause the springs to stick open once activated. The location of the thermal relief valve is distant from the center of the pump meaning heat damage can occur to seals and bearings before the valve may open.

Even with a thermal valve the operator must circulate water to reduce temperature build up in the pump as the amount of water moved by the valve is not sufficient to fully cool an overheating pump.


HOW THEY WORK
• Temperature sensitive spring
• Thermocouple and automatic valve
120° F

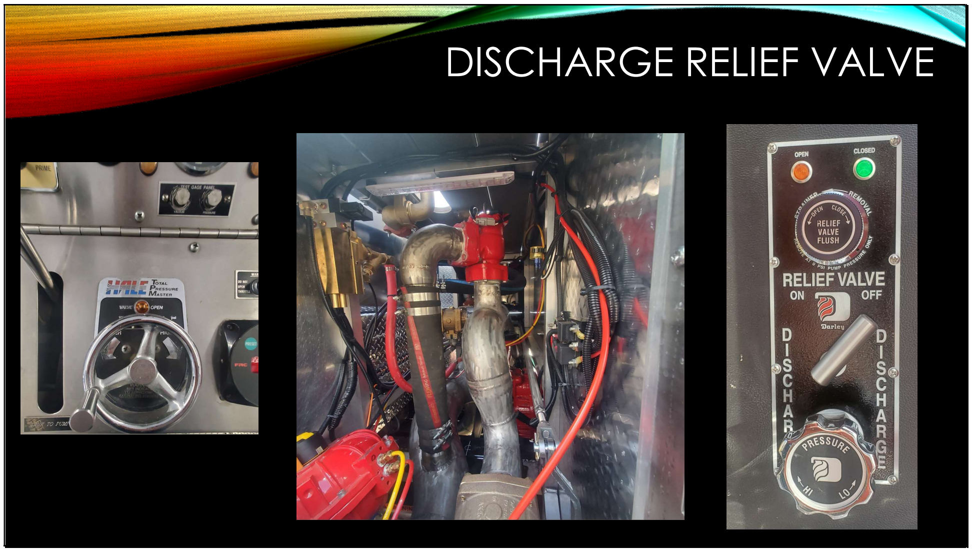

THROTTLE
Controls the process



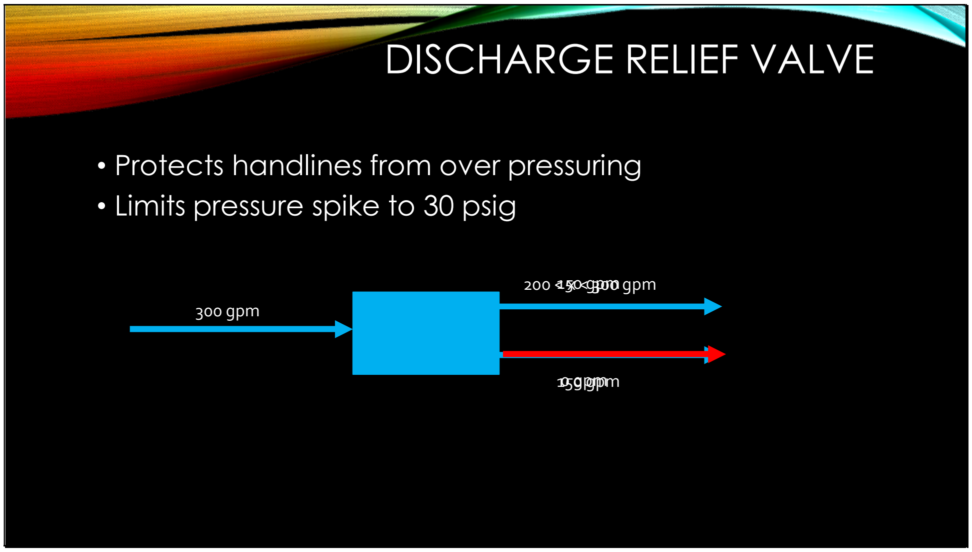
A second cable ran from the engine's throttle to the pump panel. The cable would increase the RPMs when it was shortened, turned counterclockwise, and RPMs decrease when it was lengthened, turned clockwise.

Modern heavy trucks operate with fly by wire throttle causing vernier style to be replaced.

Electronic throttles provide the operator an interface with the electronic engine management system for the adjustment of RPMs to properly set and maintain discharge pressure. Electronic throttles require the operator to manage RPM and pressure as a traditional manual throttle. The electronic throttle requires a pressure relief valve to protect against discharge pressure spikes.

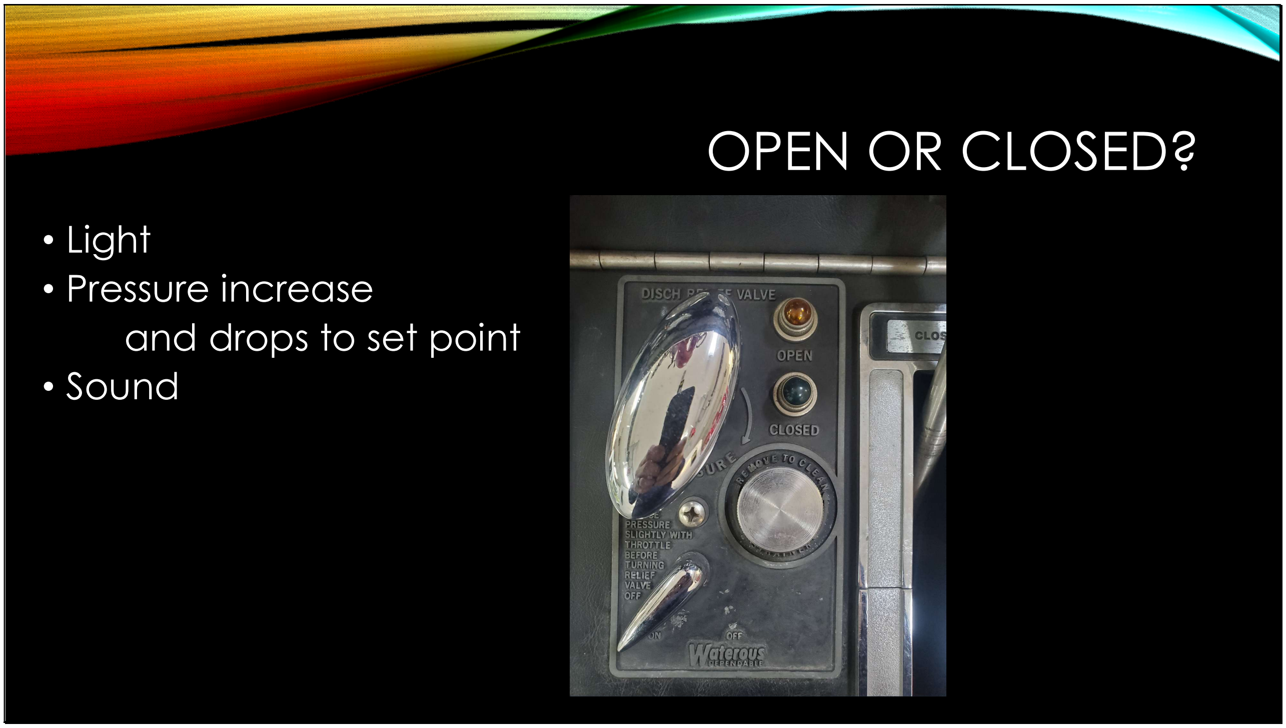


Discharge pressure relief valves dump excess pressure from the discharge manifold to the intake when the set point is exceeded. This protects the handlines from pressure surges when other lines are shutdown. The discharge relief valve vents to the intake line preventing water being seen on the ground when it opens unlike the intake relief valve. The lights are the primary indication if the valve is open or close.



NFPA 1900
The pressure discharge relief valve protects discharges from over pressurizing when other discharges are closed. When the discharge pressure exceeds the setpoint, the valve opens and dumps the excess pressure to the intake of the pump.
Pressure spikes occur because water in equals water out. If a line is closed, there is still the same amount of water coming into the pump and wanting to leave. Now instead of two paths to leave there is only one and all the water will attempt to go through the one open line. To prevent this flow and pressure spike the discharge relief valve limits the rise in discharge pressure to 30psig by dumping excess flow back to the intake.

Main takeaway: The discharge relief valve protects lines from pressure spikes due to changes in the system, lines closing or intake pressure increasing. They must always be set to the pressure of the master discharge gauge while water is flowing.

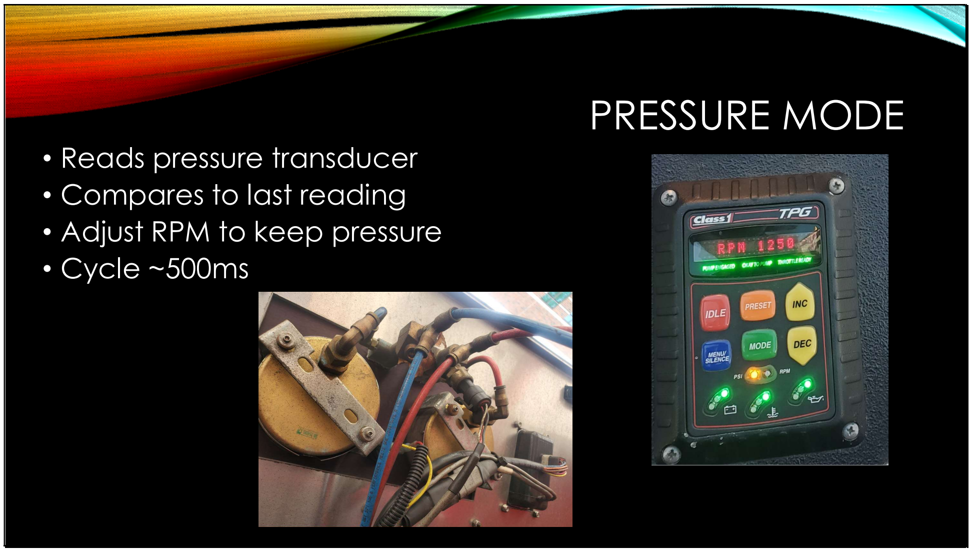


Lights do not always work. We must know other ways to know if the relief valve is open. Because this is a closed system (exhaust of the valve dumps into the intake) no water is seen on the ground when it is opened.
Increase in RPM with no increase in pressure can indicate cavitation but when hitting the pressure relief setpoint the gauge needle will move smoothly compared to cavitation. To verify the reason pressure is not increasing with RPMS, increase the discharge relief pressure, then increase the throttle and the pressure will increase to the next point. If equipped with an on/off switch, momentarily turn the valve off to see if pressure increased.

Often it is possible for the operator to hear the water flowing through the relief valve.

Every time a new pressure setpoint is needed, the relief valve needs to be adjust.

Pressure governors use the chassis fly-by-wire throttle and engine management system along with master discharge pressure transducers, and in some cases inlet pressure, coupled with control logic to manage the pressure generated by the pump.
There are three main manufactures of pressure governors: FRC, Class 1, and Innovative Controls
Some apparatus OEMs private label pressure governors
While there are many similarities, there are important differences between manufactures.
A=FRC B=Class 1 TPG+ C=Innovative Controls D= Class 1 Sentry



Pressure mode tracks the master discharge and compares it to the RPMs and pressure setpoint. If the pressure drops, the governor increases the RPMs to maintain the pressure setpoint. This happens when a second line is placed in service or the intake pressure drops. When the discharge pressure increases from a line shutting down or an increase in intake pressure the RPMs are reduced to keep the pressure at setpoint.

Some characteristics of the governor influencing its response the operator should be aware of are:

Pressure Sensitivity – How much psi can move before action. This prevents the governor from changing RPM for any little variation in pressure. This deadband is needed to maintain stable process control. Normally 5 or 10psi is needed for the governor to act.

Pressure Gain - How much psi moves per button push.

Pressure Lag - When button is held how much difference between desired and actual can occur. This prevents a large gap between the actual and desired pressure during transition. Another characteristic to maintain stable process control

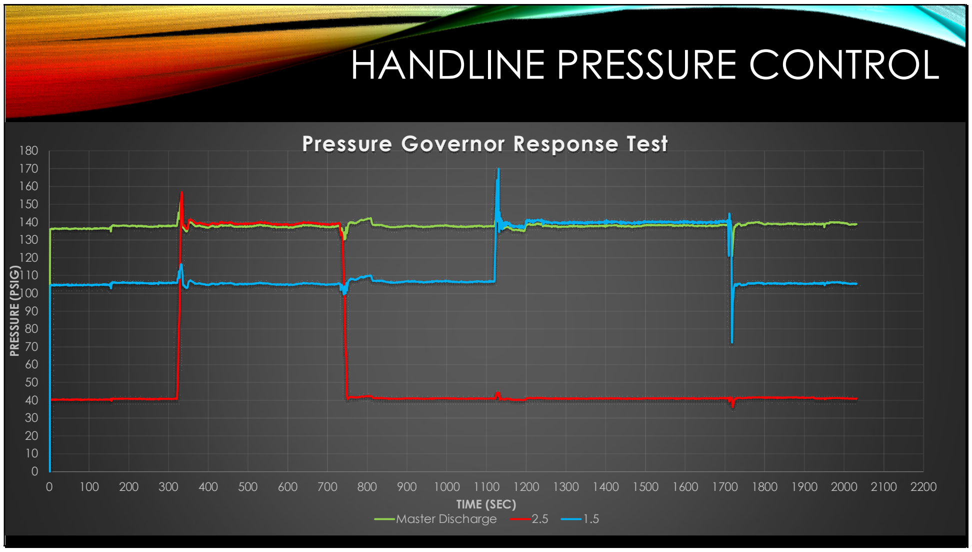
Timeouts – Time lag before action is taken.

PSI mode is needed to protect handlines form over pressurization when others are shutdown or intake pressure is increased.

It works well for fill sites, set the discharge pressure to 90psi to maintain a buffer to the 100psi fill limit. The engine will the adjust when water is flowing.

The source engine of a relay can use PSI mode but it may be advisable to initiate supply to the attack engine with the control in RPM mode, then change over once the attack engine has transitioned from tank water to being supplied by the source engine. When the intake valve of the attack engine is opened any air in the system may cause a monetary swings in pressure. This may cause the supply engine control to overreact if it is in PSI mode.

Main takeaway: Whenever people are on lines the governor must be in PSI mode.



This chart shows the response of the FRC pressure governor in PSI mode to opening and closing different size lines.
Green is the master discharge which stays fairly constant even with lines opening and closing.
Red 2 ½” 265 gpm
Blue 1 ¾” 150gpm

When either the red or blue lines are at the same pressure as the master discharge (green) the line is closed. The governor maintains pressure spikes below 30psi when the lines are closed.

Main takeaway: Even with different size lines and one gated down the governor will control pressure.

The Main limitation of PSI mode is the governor cannot go below idle to control the pressure. When the engine is at idle there is no overpressure protection.

Main takeaway: If two lines are in service and the engine is at idle, gating the discharges is the best way to bring the engine off idle to allow the governor to operate.

RUNNING AWAY FROM WATER

Model	Condition	Action 1	Action 2
FRC	Discharge pressure decrease, RPM increase does not restore pressure	RPM Limit mode	Acts as manual throttle till steady pump pressure achieved
Class 1 TPG+	Discharge pressure decreased as RPM increased	RPM to 1100RPM and ramps RPM	Does till timeout
IC	Discharge pressure decreased as RPM increase	RPM maintained	Operator must operate throttle
Class 1 Sentry	Discharge pressure decreased as RPM increased by 300	RPM maintained at pervious +300	Operator must operate throttle

LOW WATER

Model	Condition	Action 1	Action 2
FRC	15psig < Pressure < 45psig	RPM to 1100 for 7 sec	If pressure not >45psig goes to idle then repeats
Class 1 TPG+	Pressure decreases as RPMs increase	Idle	
IC	RPM increase with pressure decrease, or intake pressure less than set limit	Alarms	Limits RPMs
Class 1 Sentry	Pressure drops 5psig with RPM increase of 120 or more	Drops RPMs to 1100	Ramps RPMs for time out period

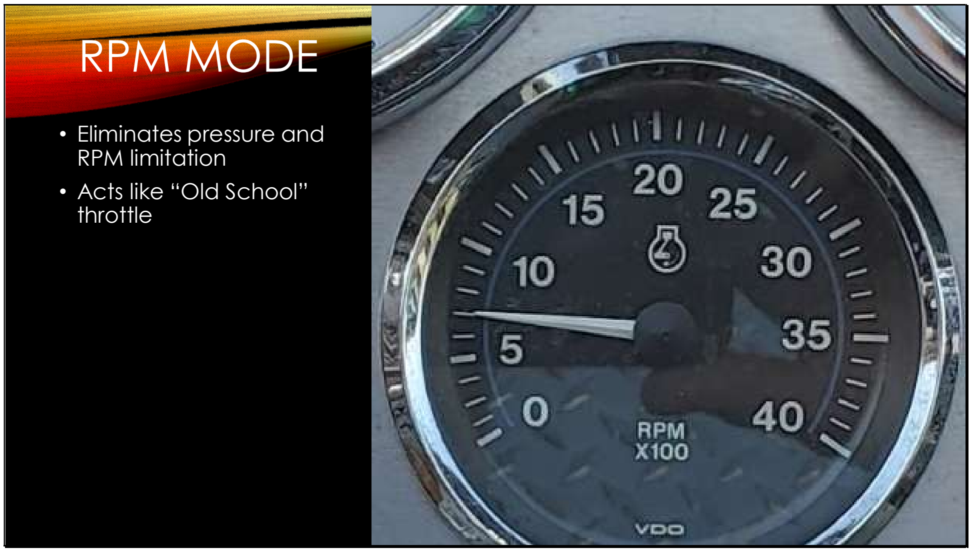
NO WATER

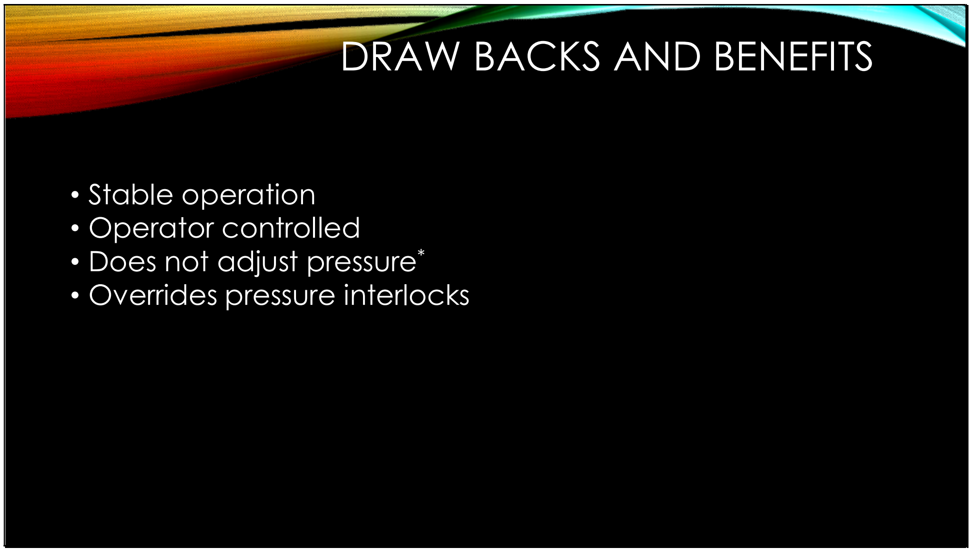
Model	Condition	Action 1	Action 2	Action 3
FRC	Pressure <15 psig	Goes to idle for 3 cycles	Cancels PSI mode	
Class 1 TPG+	Pressure <30 psig	Goes to and holds 1100RPM	After time-out: Idle	
IC	Pressure <15 psig*	Alarms	Idle	
Class 1 Sentry	Pressure < 30 psig	RPMs to 1100 and increases	RPMs hold for 3 second	Idle

* Limit can be configured

PRESSURE DROP

Model	Condition	Action 1	Action 2
FRC			
Class 1 TPG+	Discharge pressure was >50psig now <30psig	Standby mode	Idle
IC	Discharge pressure was >50psig now <30psig	Alarms	
Class 1 Sentry			


RPM MODE
• Eliminates pressure and RPM limitation
• Acts like "Old School" throttle
20
15
25
10
30
5
35
0
40
RPM
X100
VDO



Even RPM mode has protection from pressure spikes, the difference is the operator must intervein to return the pressure to the setpoint.

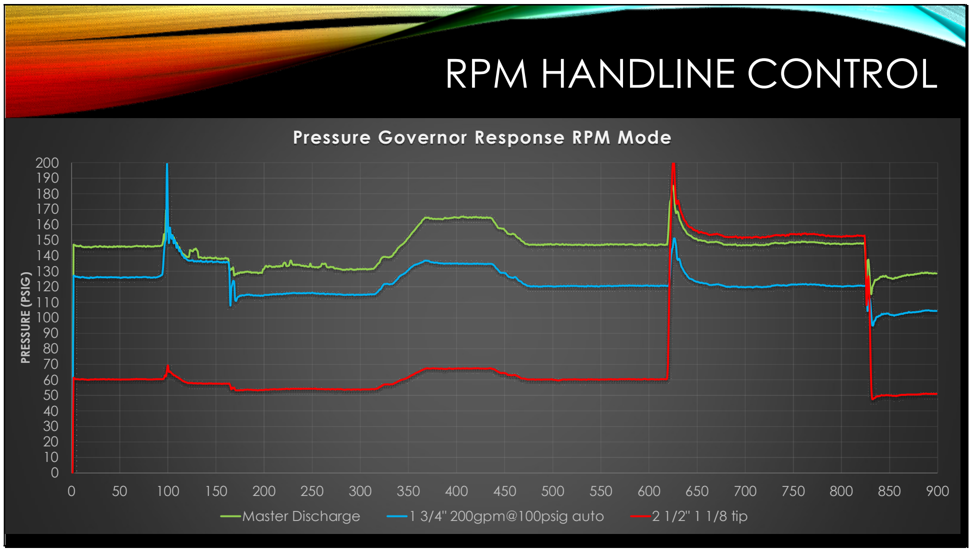
Video Setup: Recirculating with tank to pump and pump to tank open. Close the pump to tank to create a pressure spike and observe the drop in RPM and pressure.

FRC will reduce RPM to prevent a pressure spike over 30psig and Class 1 does this at 50psig.

PRESSURE LIMITATION

Model	Condition	Action
A	Pressure increase over 30psig	Reduces RPM to limit pressure spike <30psig
Class 1 TPG+	Pressure increases over 50 psig	Reduces RPM to keep psig delta <50psig
IC	Pressure increase over 30psig*	Reduces RPM to limit pressure spike <30psig
Class 1 Sentry	Pressure increases over 50 psig	Reduces RPM to keep psig delta <50psig

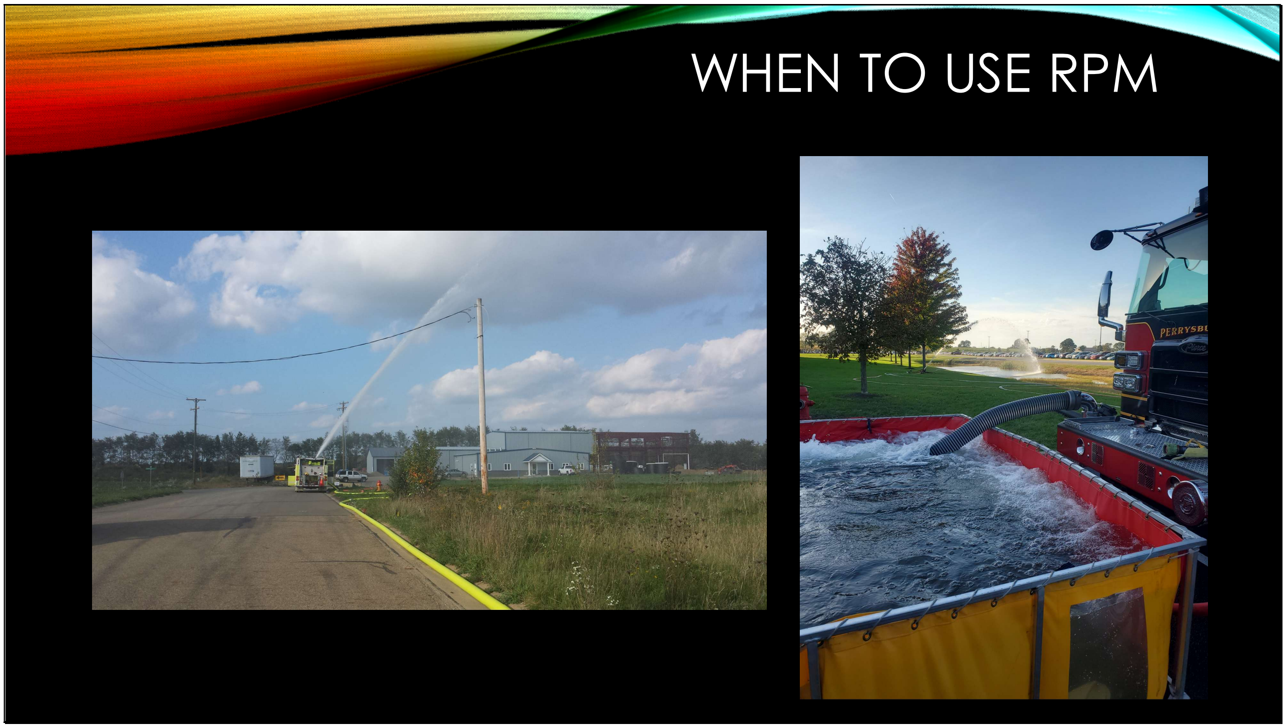
* Limit can be configured



This chart shows the response of the FRC pressure governor in RPM mode to opening and closing different size lines.
Green is the master discharge.
Red 2 ½" 265 gpm
Blue 1 ¾" 150gpm

When either the red or blue lines are at the same pressure as the master discharge (green) the line is closed. The spikes are higher in RPM mode but stay under 30psi. When the 2 1/2" line is shut, there is a larger spike in the 1 ¾" line since the system is dealing with reducing a higher volume.

Main takeaway: In RPM mode, the governor will respond to a pressure spike over 30psig. It just will not return the pressure to maintain the master discharge pressure like PSI mode. All pressure recoveries were done by the operator.

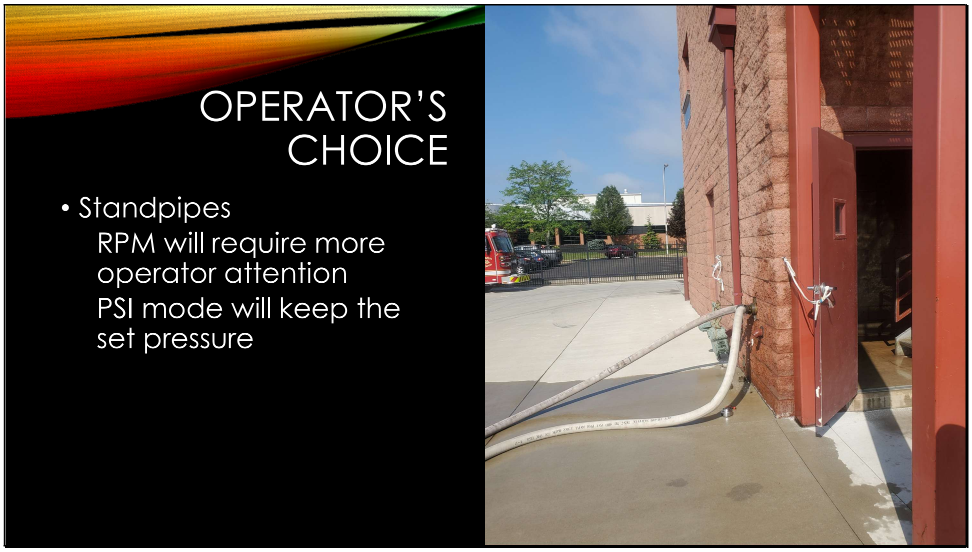


Using RPM mode when initiating draft overrides the low and no water logic. Once draft and flow are established the governor can be switch to pressure mode. The caveat to this if prime is pulled before attempting to increase throttle. If a discharge pressure is over 45psi the throttle will respond in PSI mode. The governor might fight the operator as any slugs of air pass through the system dropping the discharge pressure and kicking the governor into low/no water. The TPG will allow RPM increase with no discharge pressure but is still susceptible to variations if air is entrained in the system.

Relays: Engines in the middle should stay in RPM mode. The attack engine is in PSI mode and the source engine can be in RPM or PSI. How a relay is set with multiple engines, a middle engine sets the discharge pressure so the next engine has roughly 20psi at the intake. The source engine is the only one to change pressure when the attack engine needs more flow. This happens until the source engine is at the limit, then the other engines will increase pressure allowing the source to back down. The key in any relay is communication between the engines.

When water supply is initiated, keeping all but the attack engine in RPM mode will minimizes changes in pressure due to potential pressure swings with any air in the system when the intake valve is open. Once the supply is established the engine at the source can change to PSI mode if desired.

Main takeaway: Operators must be engaged when in RPM mode. It operates like a manual throttle. It is possible to switch to PSI mode after being in RPM without taking the engine to idle, FRC requires holding the button 3 seconds, Class 1 governors only require hitting the button.

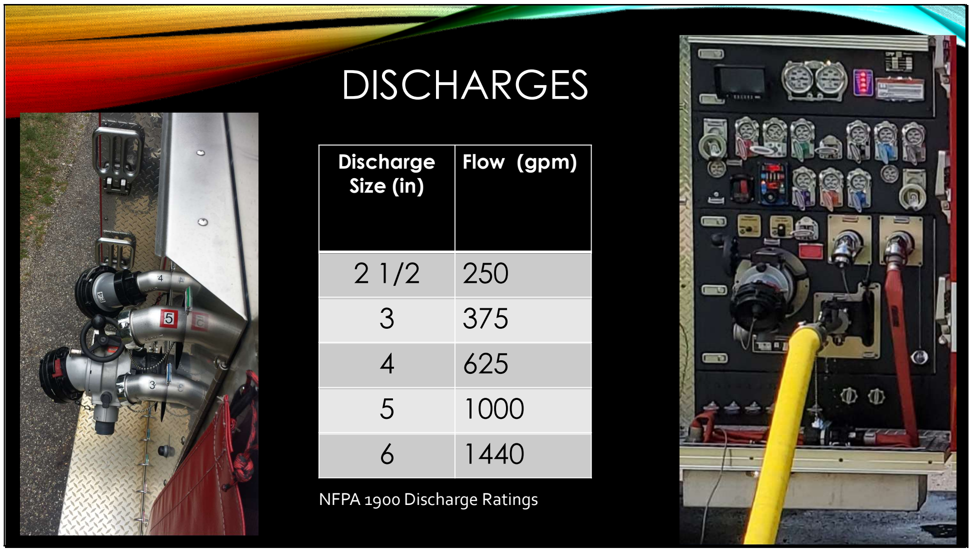


In pressure mode the pressure the governor will maintain the discharge pressure as the standpipe flow is set.   In RPM the pump discharge pressure will vary as the standpipe discharge is adjusted to the proper outlet pressure for the desired flow. As the valve is opened and flow starts the pressure will drop, this is not an issue as long as the drop in pressure stays above the needed pressure at the standpipe discharge. In PSI mode there will be some pressure swings until the desired pressure is set at the standpipe outlet.

GOVERNOR MODE USE SUMMARY

Pressure Mode	RPM Mode
When lines are in service from the engine	Initiating draft
Once draft is achieved – example fill sites	Middle engines of a relay
Source engine of a relay (once supply established)	
Either	
Standpipe	

Normally the PSI preset will be based on the most pulled pre-connect. Make sure the correct line is pulled before hitting the preset button. RPM preset is can be set to 1000RPM for drafting.
Main takeaway: Know what discharge is the basis for the pre-set pressure.



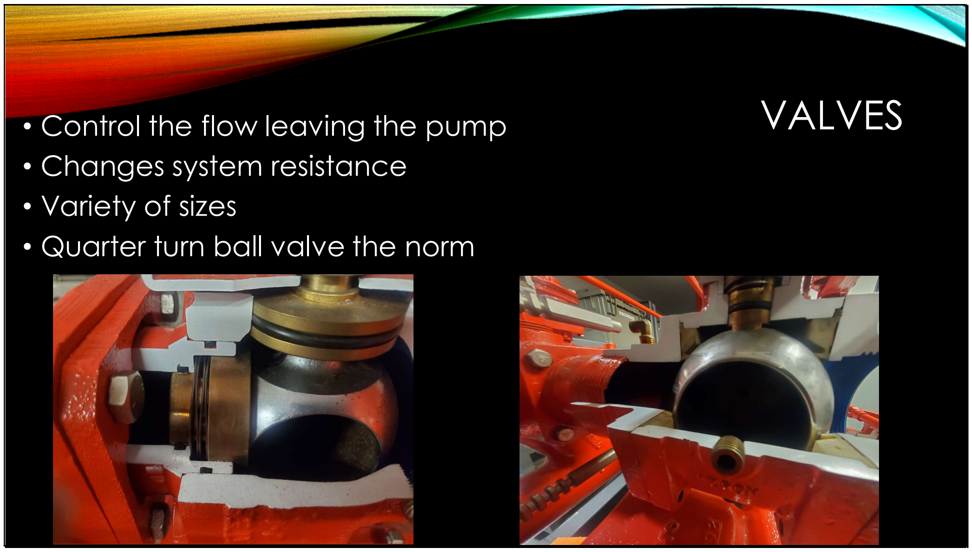
Total rating of discharges must match pump capacity. Discharges less than 2 ½ do not count towards the total flow. The size of discharge is based on the actual piping and valve size. A 3 inch LDH discharge which flares out to 4 inch at the pump panel is considered to have the capacity of a 3 inch discharge.

Any discharge 3 inches and over must have a slow opening valve.

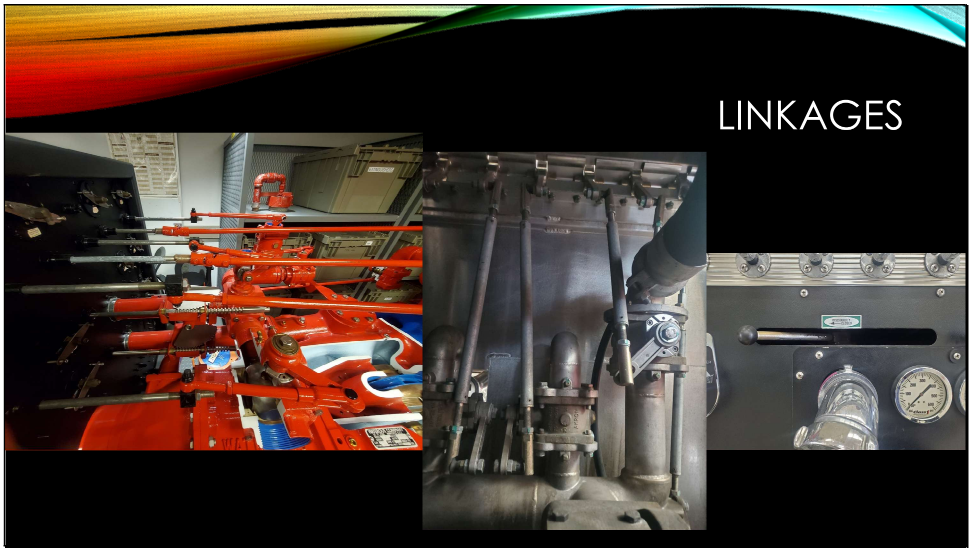
LDH discharges cannot be on operator side.

Flows in the NFPA table are based on 16ft/min velocity, in Appendix A of 1900 the allowable velocity is 32 ft/min meaning the discharges are capable of double the flow.

Main takeaway: A pump needs a quantity of discharges to meet the size of the pump. Actual flows from a discharge could be over twice the volume listed in the chart.

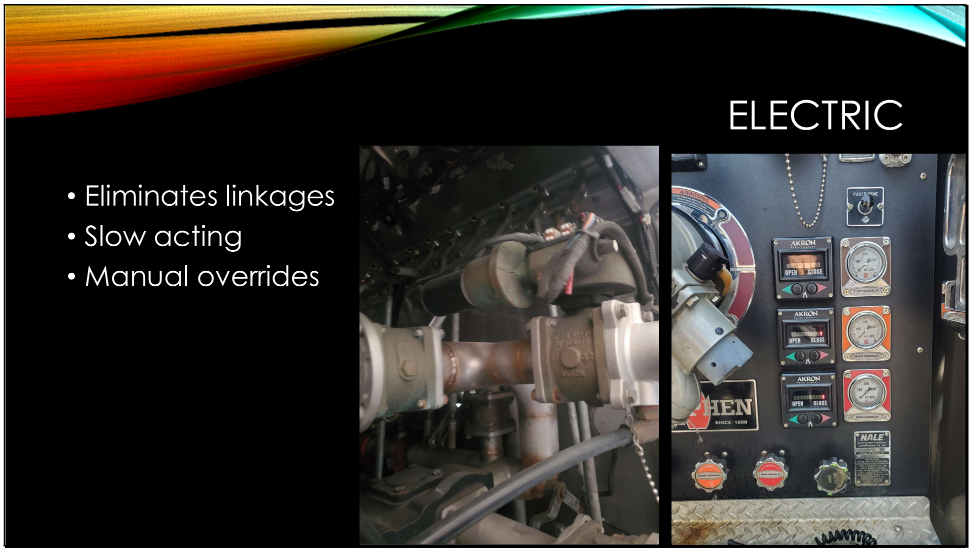


Quarter tune ball valves are the most common valves used on fire apparatus, they are compact, few moving parts, and relatively inexpensive. The main components are the ball and seat. If the seat is damaged water will leak by when the pump is engaged. This is why it is important to open the drains on a regular basis. Water coming out from the drain is an indication the valves are leaking. When a valve is leaking it will not pass the annual pump test, vacuum test with caps off.



Linkages can bind, invert, or pins fall out. It is not a bad idea to have an extra linkage pin on the apparatus. If a linkage gets stuck, open the pump house to see if the linkage is inverted. If so, manually pop the linkage back inline. If it is stuck, remove the pin at the valve and try to move the valve directly.

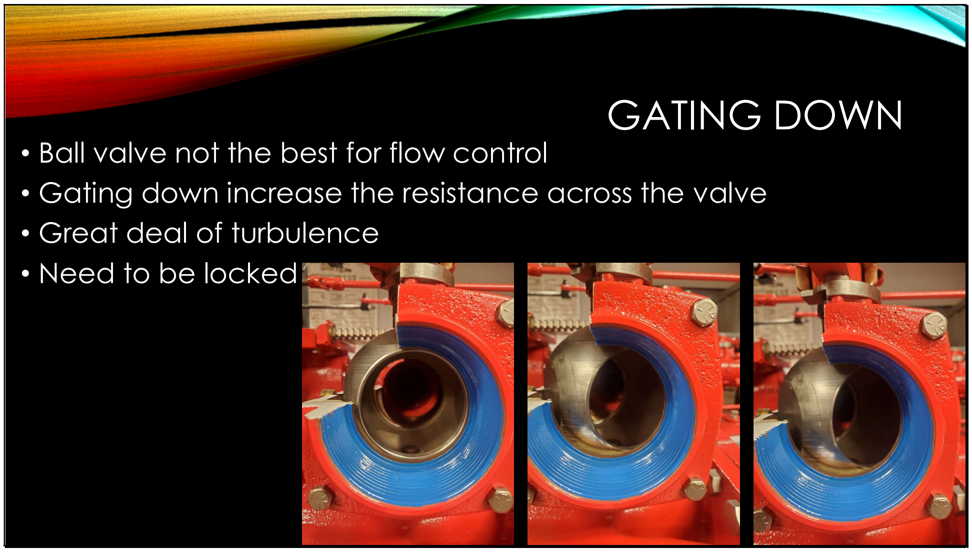
Swing valve levers like on the right are directly connected to the valve are the simplest form of valve control.



Electric valves are used when the location will not allow linkage to be ran, or the valve needs to be slow acting.
Electric valve will have a manual backup. This is normally a hex shaft pointing away from the drive motor. Have the proper tools on the apparatus to operate the manual backup on the electric valves.

Electric valves can be set to go fully open with one tap or to a selected opening percentage. Push and hold the controller to take the valve to a position other than the preset. It is important to know how the valves on your apparatus are setup.

Electric valve controllers can go out of calibration. The operator must know the indication of an out of calibration valve controller and how to calibrate the valve.

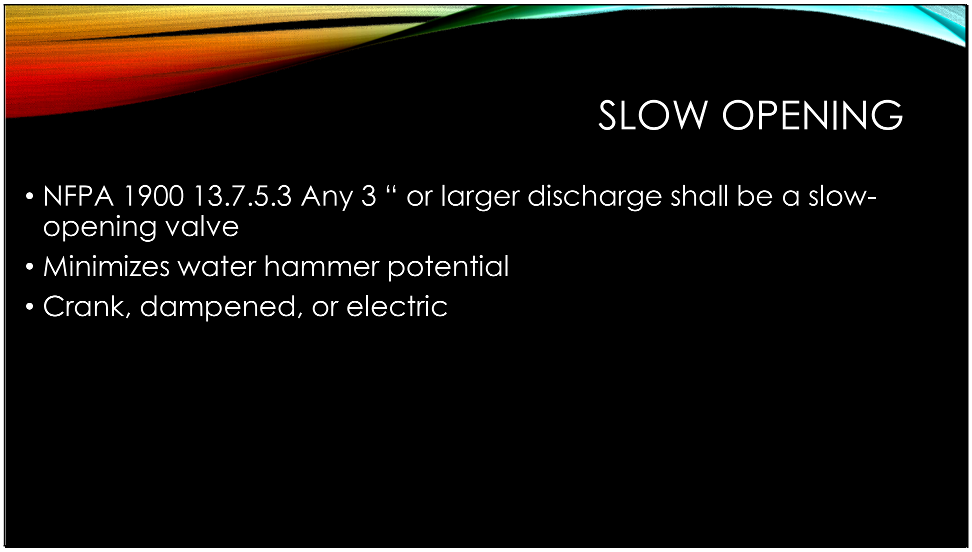


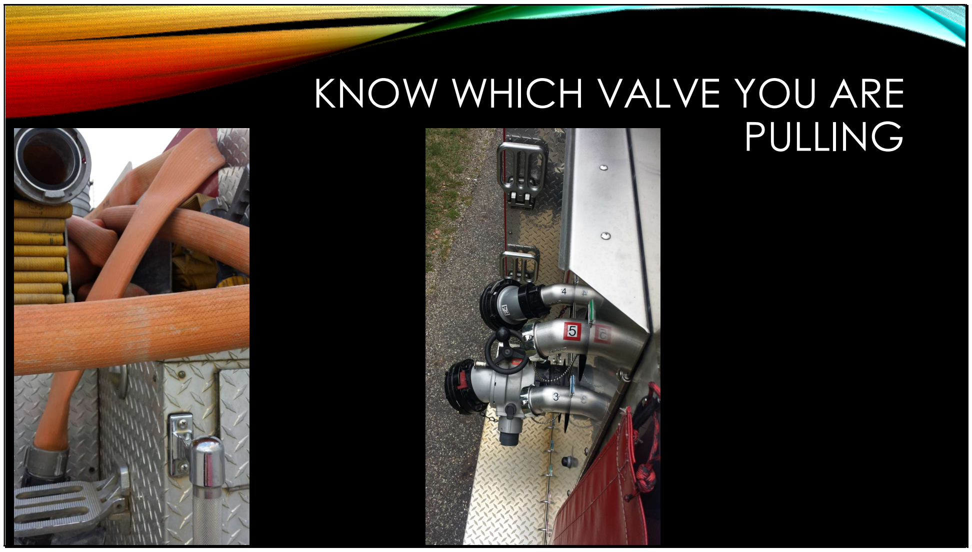
Gating down is used to change the flow through a line requiring less pressure than the master discharge pressure which is set for the highest line pressure required.

Discharge with the highest pressure sets the throttle.

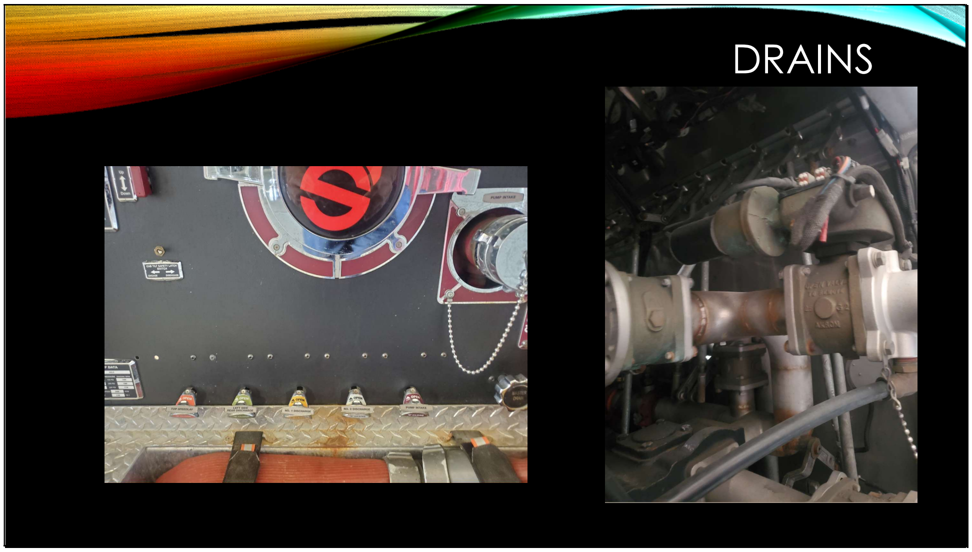
Ball valves are not the best valve choice for controlling flow. Flow is controlled by changing the flow area of the valve and increasing the turbulence through the valve. It is important to lock gated valves to prevent them from closing down during prolong operation. Older valves have a greater tendency to walk close as the seats are not as tight. Marking the pressure gauge helps to identify valve which have walked open.

Added turbulence and increase velocity through the reduced area will impact the pressure reading if the tap is too close to the valve. For discharges normally requiring gating, test the gate pressure at discharge using an inline pressure gauge.


SLOW OPENING
• NFPA 1900 13.7.5.3 Any 3 " or larger discharge shall be a slow-opening valve
• Minimizes water hammer potential
• Crank, dampened, or electric



Opening the wrong discharge will slow the operation and potentially injury personnel. Verify the discharge being opened is the correct one. If needed, add additional labeling for easier visibility. Color of discharge label must match the color of the discharge handle. Color coding the hose to match will add another level of indication to the operator on the fire ground.



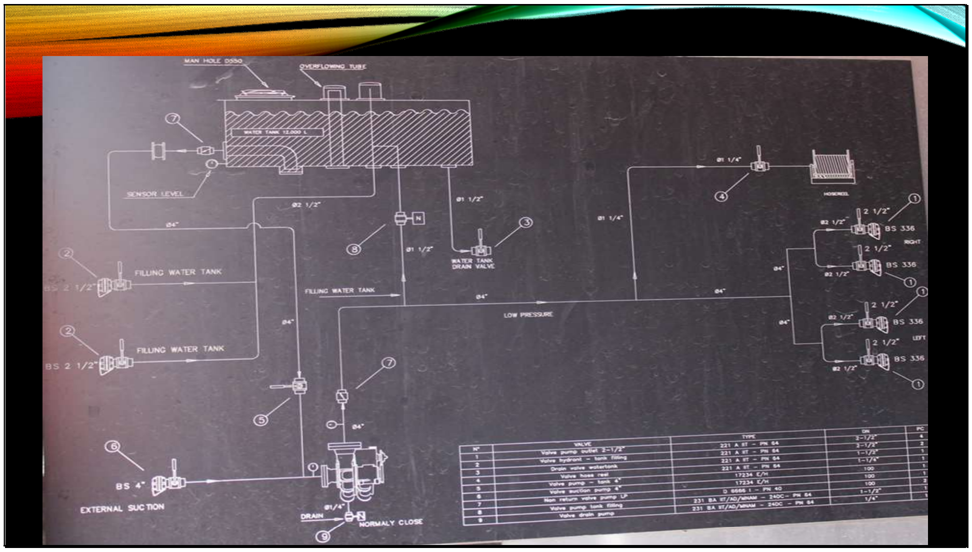
1900 13.8.1 A readily accessible drain valve(s) that is marked with labels as to its function shall be provided to allow for draining of the pump and all water carrying lines.

Drains are the lowest point in the system where debris will settle. The drains are used to remove pressure from charge lines once valves are closed. These are valuable to remove water from plumbing should valves leak on capped discharges to prevent someone from getting drenched when he/she removes the cap. Drains can be left open to prevent the buildup of water in the first place. In winter, open drains prevent water from being trapped and freezing in the discharges and potentially damaging valves and gauges.

With the gauge pickups moving to the drains, it is important to blow down the drains.

Blowing down drains involve capping the discharges, opening the valves, and pressurizing the system to 10 to 20 psi to push debris out the drains.

Main takeaway: It is important to blow down and exercise drains.



A good exercise for an operator to undertake to better understand the controls of the apparatus is making a schematic of all the valves, reliefs and drains.


Thank you!
Ed Collet
edccollet@gmail.com
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VA EL AGUA LLC