VALVE CONTROLS

1st Edition

PROFESSIONAL DEVELOPMENT COURSE

Technical Learning College

This book is dedicated to the memory of one of TLC's favorite Instructors, Little Jerry, overall water expert and wonderful person. We miss you very much. Our classes will never be the same.

Important Information about this Manual

This manual has been prepared to educate operators in the general education of valves, valve system design, valve operation, and hydraulic principles including basic mechanical training and different valve related applications. For most students, the study of valving and hydraulics is quite large, requiring a major effort to bring it under control.

This manual should not be used as a guidance document for employees who are involved with cross-connection control. It is not designed to meet the requirements of the United States Environmental Protection Agency (**EPA**), the Department of Labor-Occupational Safety and Health Administration (**OSHA**), or your state environmental or health agency. Technical Learning College or Technical Learning Consultants, Inc. makes no warranty, guarantee or representation as to the absolute correctness or appropriateness of the information in this manual and assumes no responsibility in connection with the implementation of this information.

It cannot be assumed that this manual contains all measures and concepts required for specific conditions or circumstances. This document should be used for educational purposes and is not considered a legal document. Individuals who are responsible for hydraulic equipment, cross-connection control, backflow prevention or water distribution should obtain and comply with the most recent federal, state, and local regulations relevant to these sites and are urged to consult with OSHA, the EPA and other appropriate federal, state and local agencies.

CEU Course Description

VALVE CONTROLS CEU TRAINING COURSE

This short technical continuing education course will address the function, application and selection of various valves (control devices) used in every stage of the water treatment cycle from raw water intake to the treated wastewater discharge. This course will cover criteria for selecting and applying check valves, air relief, automatic valves on wells, in raw water pumping stations, in the water treatment plant, and in potable water storage and distribution systems as well as in sewage lift stations, on force mains, in wastewater treatment plants, on effluent and reuse pumping. Of the 83 different TLC courses, this course is designed for the sixth grade reading level for Operators that do not have upper level reading skills.

This course will also review basic hydraulic fundamentals and principles, i.e. water hammer, head, and pressure. Following this short course, the student will develop an understanding of the different classifications and uses of commonly found valves. This training course will present several familiar topics in valve related installations and problems encountered. ***You will not need any other materials for this course.***

Water Distribution, Well Drillers, Pump Installers, Water Treatment Operators, Wastewater Treatment Operators, Wastewater Collection Operators, Industrial Wastewater Operators and General Backflow Assembly Testers. The target audience for this course is the person interested in working in a water or wastewater treatment or distribution/collection facility and/or wishing to maintain CEUs for certification license or to learn how to do the job safely and effectively, and/or to meet education needs for promotion.

Valve Controls Section Course Outline
This course will cover most valves and control devices found in the water and wastewater field. The student will develop an ability to describe various and interesting valves, uses, applications and understand the operation of most valves as well as troubleshooting and the effects of water hammer. 365 Minutes

Course Learning Objectives and Timed Outcomes

- Basic surge pressure wave theory.
  Describe the effects of a pressure surge or wave and the conditions that cause it.
- Linear Valves. 55 Minutes
  Contrast linear and rotary valves.
  Define gate valves and explain their primary use and design.
  Analyze the reasons for the preferred orientation of a knife gate valve.
- Rotary Valves. 160 Minutes
  Explain the purpose of globe valves, how to install them and where they are used.
  Analyze problems with globe valves and possible solutions.
  Distinguish between pressure-sustaining valves and pressure-reducing valves.
  Describe the installation and purpose of an insertion valve.
  Identify the distinguishing characteristic of needle valves.

Summarize the purpose of bellow seal valves and list their uses.
Examine the application of plug valves.
List the uses for angle valves.
Describe the physical characteristics of ball valves, their purposes and related gearing issues.
Recognize butterfly valves, installation specs, applications and problem-solving techniques.
Evaluate directional control valves, their physical characteristics and their purposes.
Compare proportional valves vs. on/off valves.
Analyze control valves in terms of sensitivity.

- Pressure Relief and Pressure regulating Valves. 30 Minutes
  Explain the purposes of sequence and shuttle valves.
  Describe the functions of PRVs and how they work.
  Differentiate between pressure relief and pressure regulating valves.
- Check Valves. 15 Minutes
  Define pilot controlled check valves.
  Define counterbalance valves.
- Surge preventing pump control valves, Surge protecting anticipator and relief valves. 30 Minutes
  Contrast the uses of surge preventing pump control valves and surge protecting anticipator and relief valves.
  Understand the water hammer formula.
- Pumping cost comparisons for pump stations.
- Compare Pressure control, Level control and Flow control. 20 Minutes
- Cavitation causes and solutions. 30 Minutes
  Describe damage caused by cavitation and water hammer.
  Analyze vibration in relation to pulsation.
- Describe Valve sizing considerations.
- List advantages of automatic air valves for water and sewage systems. 25 Minutes

Training Course Goals
Valves and Control Devices
I. Explore Valves and Control Devices
A. Linear Valves.
B. Rotary Valves.
C. Air Valves.
D. Check Valves.
E. Pressure Relief Valves.
F. Pressure Reducing Valves.
II. Hydraulic Familiarization
A. Hydraulic Definitions
B. Fluid Terms
C. Water Hammer
III. Advanced Valve Application and Valve Troubleshooting Competency

Prerequisites: None

Accreditation Formula for Figuring CEU Credit
The results of beta-testing were used in conjunction with a formula to determine average student time for accreditation purposes for intended audiences. This formula may not work for unintended audiences.

1 page of text = 2 minutes of student time.
1 word practice problem = 1 minute of student time.
1 word quiz/exam question = 1 minute of student time.
Written essay question = 24 minutes of student time. This time is based upon three paragraphs utilizing the four "C"s of writing. Answer may also be scored for English and/or Grammar course credit.
Math question = 3 minutes of student time. Some math questions may qualify for twice or three times this standard time, depending on the amount of different math conversions utilized to solve the answer. For example, in a math question that utilizes two different conversions to solve the answer, the average time would be adjusted to 6 minutes.
The above time averages may change with certain audiences.

**CEU is awarded based on guidelines established by the International Association of Continuing Education and Training (IACET).

Final Examination for Credit
Opportunity to pass the final comprehensive examination is limited to three attempts per course enrollment.

Course Procedures for Registration and Support
All of Technical Learning College's correspondence courses have complete registration and support services offered. Delivery of services will include, e-mail, web site, telephone, fax and mail support. TLC will attempt immediate and prompt service.

When a student registers for a distance or correspondence course, he/she is assigned a start date and an end date. It is the student's responsibility to note dates for assignments and keep up with the course work. If a student falls behind, he/she must contact TLC and request an end date extension in order to complete the course. It is the prerogative of TLC to decide whether to grant the request. All students will be tracked by their social security number or a unique number will be assigned to the student.

Instructions for Assignment
The ***Valve Controls*** CEU training course uses a multiple choice type answer key. You can find a copy of the answer key in the back of this course manual or in Word format on TLC's website under the Assignment Page. You can also find complete course support under the Assignment Page.
You can write your answers in this manual or type out your own answer key. TLC would prefer that you type out and e-mail the final exam to TLC, but it is not required.

Feedback Mechanism (examination procedures)
Each student will receive a feedback form as part of their study packet. You will be able to find this form in the rear of the course or lesson.

Security and Integrity
All students are required to do their own work. All lesson sheets and final exams are not returned to the student to discourage sharing of answers. Any fraud or deceit and the student will forfeit all fees and the appropriate agency will be notified.

Grading Criteria
TLC will offer the student either pass/fail or a standard letter grading assignment. If TLC is not notified, you will only receive a pass/fail notice.

Required Texts
The ***Valve Controls*** CEU training course will not require any other materials. This course comes complete. No other materials are needed.

Recordkeeping and Reporting Practices
TLC will keep all student records for a minimum of seven years. It is your responsibility to give the completion certificate to the appropriate agencies.

ADA Compliance
TLC will make reasonable accommodations for persons with documented disabilities. Students should notify TLC and their instructors of any special needs. Course content may vary from this outline to meet the needs of this particular group. Please check with your State for special instructions.

You will have 90 days from receipt of this manual to complete it in order to receive your Continuing Education Units (**CEUs**) or Professional Development Hours (**PDHs**). A score of 70% or better is necessary to pass this course. If you should need any assistance, please email all concerns and the final test to: info@tlch2o.com.

A Ball Stop with my favorite copper fitting, a flare fitting. It is difficult to find and even harder to find a person that knows how to flare copper correctly. I personally think that this may be the best copper fitting of all time, even stronger than sweating.

Educational Mission
The educational mission of TLC is:

To provide TLC students with comprehensive and ongoing training in the theory and skills needed for the environmental education field,

To provide TLC students opportunities to apply and understand the theory and skills needed for operator certification and environmental education,

To provide opportunities for TLC students to learn and practice environmental educational skills with members of the community for the purpose of sharing diverse perspectives and experience,

To provide a forum in which students can exchange experiences and ideas related to environmental education,

To provide a forum for the collection and dissemination of current information related to environmental education, and to maintain an environment that nurtures academic and personal growth.

Please call an Instructor if you need any assistance with this course or assignment. We can also come to your facility. Always check with your State agency to see if this course is accepted.

Toll Free (866) 557-1746

TLC can come to your facility and provide classroom instruction. To date, we have trained over 10,000 operators. We like to utilize hands-on training as well as distance based training. Let us know how we can serve you. Your business is very important to us. Send us your questions; we have over 13 Instructors to answer your questions.

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Common Hydraulic Terms

Head
The height of a column or body of fluid above a given point expressed in linear units. Head is often used to indicate gauge pressure. Pressure is equal to the height times the density of the liquid.

Head, Friction
The head required to overcome the friction at the interior surface of a conductor and between fluid particles in motion. It varies with flow, size, type and conditions of conductors and fittings, and the fluid characteristics.

Head, Static
The height of a column or body of fluid above a given point

Hydraulics
Engineering science pertaining to liquid pressure and flow.

Hydrokinetics
Engineering science pertaining to the energy of liquid flow and pressure.

Pascal's Law
A pressure applied to a confined fluid at rest is transmitted with equal intensity throughout the fluid.

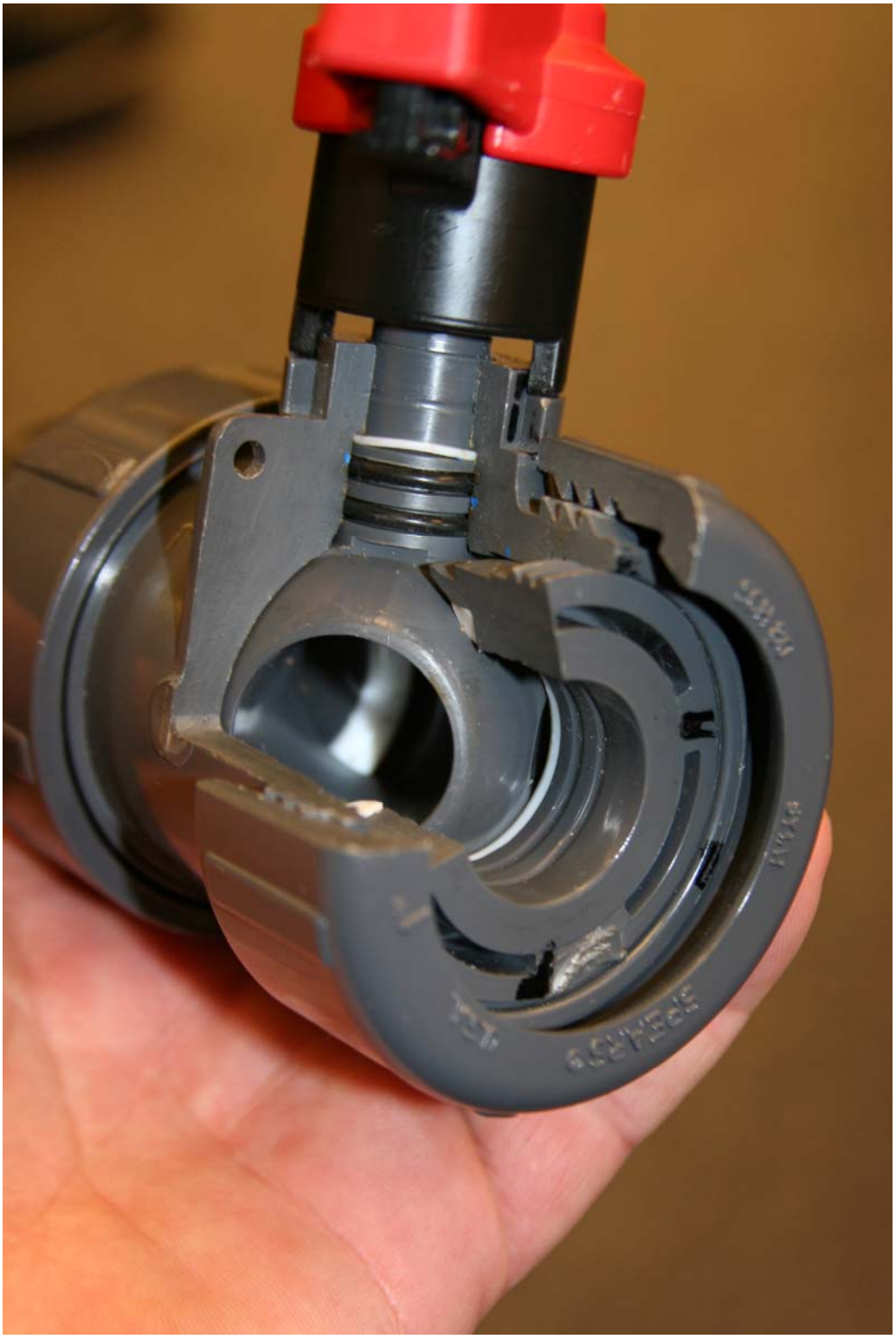
Pressure
The application of continuous force by one body upon another that it is touching; compression. Force per unit area, usually expressed in pounds per square inch (Pascal or bar).

Pressure, Absolute
The pressure above zone absolute, i.e. the sum of atmospheric and gage pressure. In vacuum related work it is usually expressed in millimeters of mercury. (mmHg).

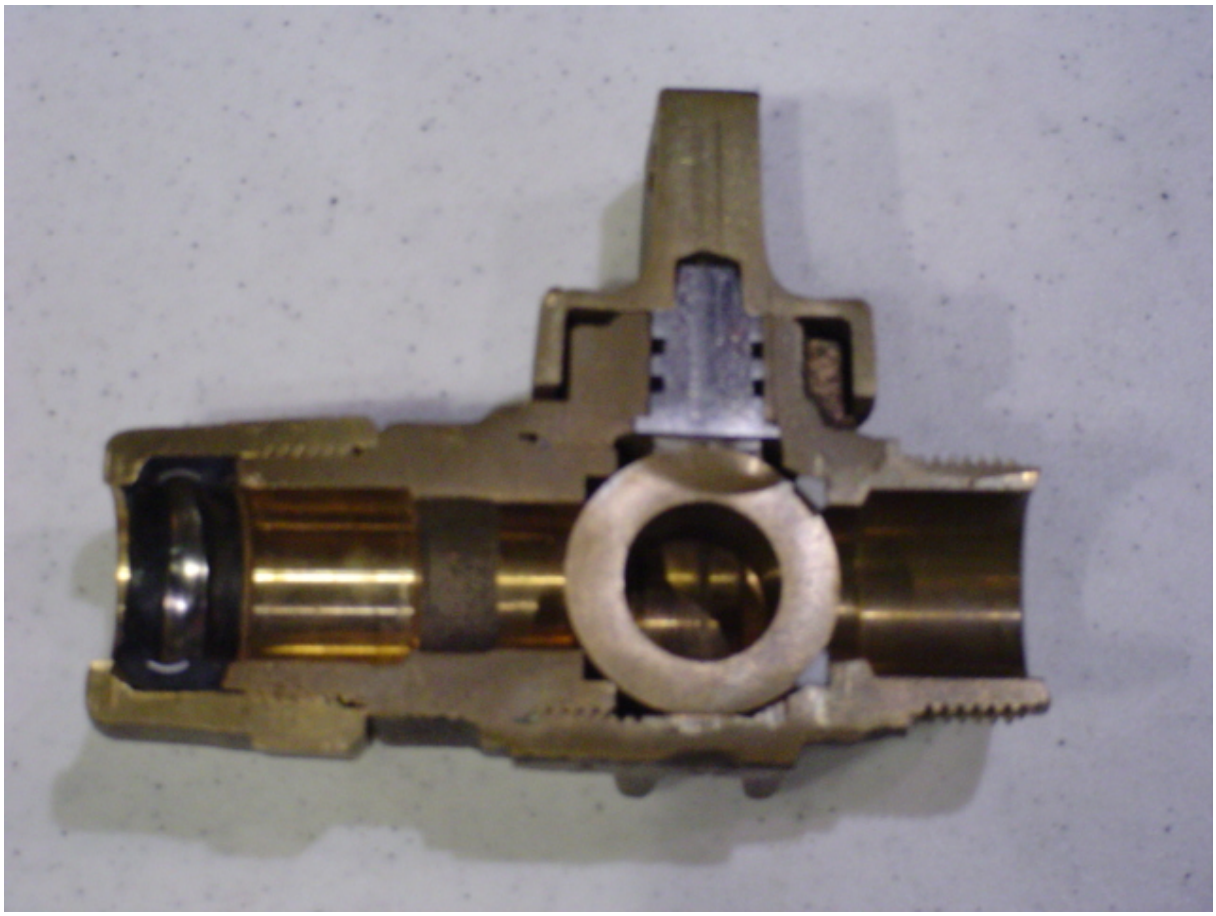
Pressure, Atmospheric
Pressure exported by the atmosphere at any specific location. (Sea level pressure is approximately 14.7 pounds per square inch absolute, 1 bar = 14.5psi.)

Pressure, Gauge
Pressure differential above or below ambient atmospheric pressure.

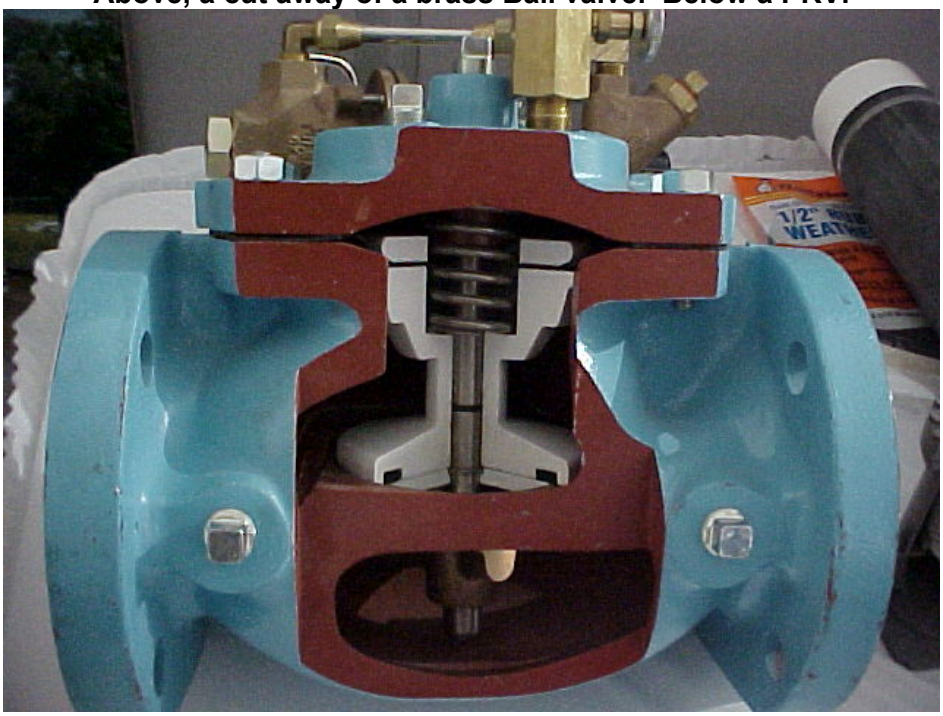
Pressure, Static
The pressure in a fluid at rest.



A cut away of a ball valve. The ball is made of plastic in this valve. The balls are not perfectly round but are egg shaped or elongated to make a good seal.



Above, a cut away of a brass Ball valve. Below a PRV.



Introduction to Water System Valves

System design depends on the area that you live. You may be a flatlander, like in Texas, and the services could be spread out for miles. You may live in the Rocky Mountain area and have many fluctuating elevations. Some areas may only serve residents on a part time basis and water will sit for long periods of time, while other areas may have a combination of peaks and valleys with short and long distances of service. Before you design the system you need to ask yourself some basic questions.

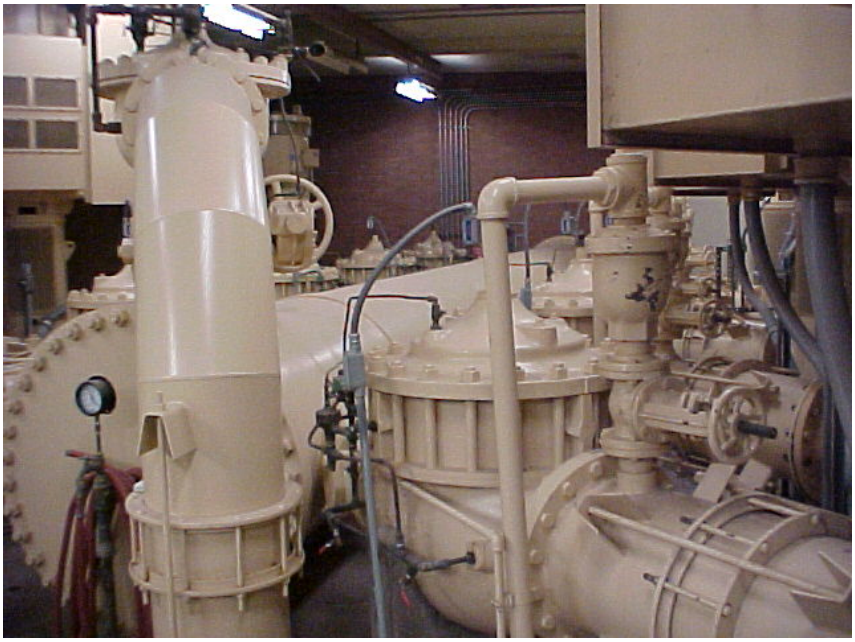
1. ***What is the source of water?***
2. ***What is the population?***
3. ***What kind of storage will I need for high demand and emergencies?***
4. ***How will the pressure be maintained?***

System Elements
The elements of a water distribution system include distribution mains, arterial mains, storage reservoirs, and system accessories. These elements and accessories are described as follows:

DISTRIBUTION MAINS Distribution mains are the pipelines that make up the distribution system. Their function is to carry water from the water source or treatment works to users.

ARTERIAL MAINS Arterial mains are distribution mains of large size. They are interconnected with smaller distribution mains to form a complete gridiron system.

STORAGE RESERVOIRS Storage reservoirs are structures used to store water. They also equalize the supply or pressure in the distribution system. A common example of a storage reservoir is an aboveground water storage tank.



The inside of a booster pump station, notice the PRV with air relief valve.

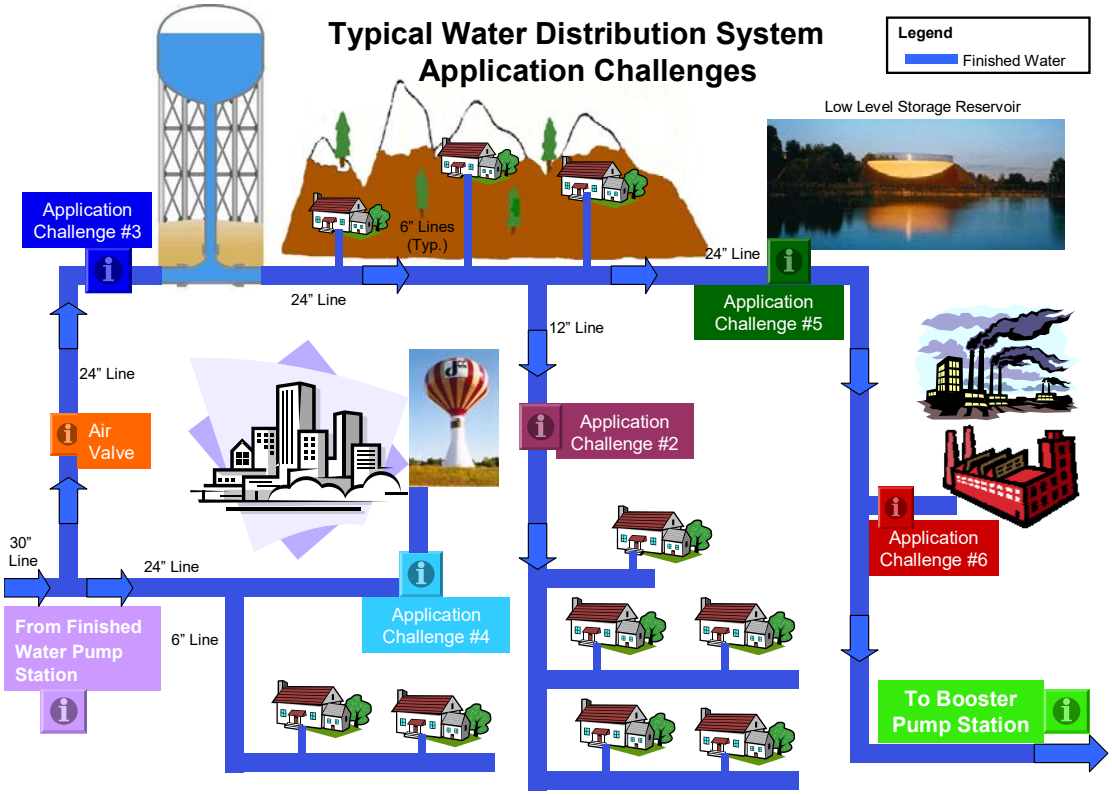
Commonly found s*ystem accessories include the following:*

Booster stations are used to increase water pressure from storage tanks for low-pressure mains.

Valves control the flow of water in the distribution system by isolating areas for repair or by regulating system flow or pressure. We will explore this component later in this course.

Two different styles of Gate Valves
Top picture is valve ready for a valve replacement.
Bottom picture is OS&Y commonly found on fire lines.
(Outside Screw and Yoke) As the gate is lifted or opened, the stem will rise.

Gate valves should be used in the distribution system for main line isolation.



System Layouts

There are three general ways systems are laid out to deliver water (Picture your quarter section layouts). They include:

A. Tree systems
B. Loop or Grid systems
C. Dead-end systems. ***Taste and odor problems.***

Tree System

Older water systems frequently were expanded without planning and developed into a treelike system. This consists of a single main that decreases in size as it leaves the source and progresses through the area originally served. Smaller pipelines branch off the main and divide again, much like the trunk and branches of a tree. A treelike system is not desirable because the size of the old main limits the expansion of the system needed to meet increasing demands. In addition, there are many dead ends in the system where water remains for long periods, causing undesirable tastes and odors in nearby service lines. The most reliable means to provide water for fire fighting is by designing redundancy into the system. There are several advantages gained by laying out water mains in a loop or grid, with feeder and distributor mains interconnecting at roadway intersections and other regular intervals.

Always remember to use shoring and proper safety equipment when working underground. You should also wear your hard hats as well. We are professionals and need to look like it. Bottom picture is two nitwits going to be killed. 15 feet deep and no way out. Let's think before doing work.

Distribution Valves

The purpose of installing shutoff valves in water mains at various locations within the distribution system is to allow sections of the system to be taken out of service for repairs or maintenance without significantly curtailing service over large areas.

Valves should be installed at intervals not greater than 5,000 feet in long supply lines and 1,500 foot in main distribution loops or feeders. All branch mains connecting to feeder mains or feeder loops should have valves installed as close to the feeders as practical. In this way, branch mains can be taken out of service without interrupting the supply to other locations.

In the areas of greatest water demand or when the dependability of the distribution system is particularly important, valve spacing of 500 feet may be appropriate.

At intersections of distribution mains, the number of valves required is normally one less than the number of radiating mains. The valve omitted from the line is usually the one that principally supplies flow to the intersection. Shutoff valves should be installed in standardized locations (that is, the northeast comer of intersections or a certain distance from the center line of streets), so they can be easily found in emergencies. All buried small- and medium-sized valves should be installed in valve boxes. For large shutoff valves (about 30 inches in diameter and larger), it may be necessary to surround the valve operator or entire valve within a vault or manhole to allow repair or replacement.

Classification of Valves

There are two major classifications of water valves: **Rotary and Linear**. Linear is a fancy word for up and down or blade movement.

Gate Valve *Linear Valve Our primary Linear valve*
The most common valve in the distribution system. Primarily used for main line shut downs. Should be exercised on annual basis.

Gate valves are used when a straight-line flow of fluid and minimum flow restriction are needed. Gate valves are so-named because the part that either stops or allows flow through the valve acts somewhat like a gate. The gate is usually wedge-shaped. When the valve is wide open the gate is fully drawn up into the valve bonnet. This leaves an opening for flow through the valve the same size as the pipe in which the valve is installed.

Therefore, there is little pressure drop or flow restriction through the valve. Gate valves are not suitable for throttling purposes. The control of flow is difficult because of the valve's design, and the flow of fluid slapping against a partially open gate can cause extensive damage to the valve. Except as specifically authorized, gate valves should not be used for throttling.

The Singing Key
I always like to listen to the Valve Key when shutting down a Gate valve. You will easily hear it sing as you shut the water off or leak by. It is very easy to create a water hammer when opening or closing a Gate valve. Always take your time when operating a Gate valve or any valve. I know that most of you will not listen to me and you will end up breaking plastic water services and customer's water lines at first. Next, you'll move up to water main breaks. We like to blame the Fire Department or Street Sweepers for water hammers, and they should be blamed, but most water hammers are created by water personnel. Yes, I said it. A great example is watching a rookie shut down or open a fire hydrant. These young rookies like to turn the hydrant on or off as fast as possible, like the Firemen do. Pretty soon, the hydrant starts chattering and pumping. The ground feels like an earthquake and the rookie pretends that nothing is happening. We've all done this and if you haven't, you've probably never worked in the field.

Problems
Valve Jammed Open
Dr. Durbin recommends that opened valves should not be jammed-tight on the backseat.

Always back the valve-off a quarter turn from the fully opened position.

Note that motor operated valves coast inevitably to the backseat by tripping on a limit switch. Valves should not be back seated on torque.

Valve Jammed Closed
Variations in the temperature and/or pressure of the working fluid are often the cause of a valve failing to open.

Thermal binding can occur in high temperature situations depending on the seat and wedge material, length of exposure and closing torque applied. Thermal binding can cause galling on the valve sealing surfaces as well as on the guides.

A valve can lock in the closed position when high pressure enters the cavity and has no way to escape. This is known as over-pressurization.

If Excessive Torque is Needed to Work the Valve
Variations in the temperature and/or pressure of the working fluid are often the cause of a valve failing to open.

Thermal binding can occur in high temperature situations depending on the seat and wedge material, length of exposure and closing torque applied. Thermal binding can cause galling on the valve sealing surfaces as well as on the guides. A valve can lock in the closed position when high pressure enters the cavity and has no way to escape. This is known as over-pressurization. We will cover this in a later section.

Single direction sealing gate valves have a nameplate on the side of the valve that has a relief hole or pressure equalizer. This should be the high pressure side when the valve is closed.

Here is a nasty 4 inch broken gate valve with serious Tuberculation. The valve is broken closed. The rust particles are sharp and can easily cut the water service worker. The flange bolts or Tee bolts were cut off to replace this valve. The rubber gasket will leave a black ink like stain on your clothes and in the water line as well. You will see lots of nasty stuff in the top portion of a valve. Some engineers or big shots refer to this area of the valve as the "Angular space". If they really knew that this space contained nasty particles or debris and sediment they would never visit your Yard or facility again.

One practice that I am not sure about is the common procedure of only removing the bonnet or removing the guts of a closed valve and keeping the valve body on the line. I guess that sometimes this practice is necessary, and I don't like removing the guts and packing of cement and a redwood plug in the stem hole but it happens. Dr. Durbin's advice, Working on wastewater and water valves is difficult practice because of mud, debris and because water lines are under pressure, but be super careful of rust particles cutting your skin. Get in line at the Doctor's or Health Provider's facility and get all of your shots. Especially Tetanus and Hepatitis. Some of you will need Rabies as well, not because of the water but because of your wild animal make-up. I know some of you will fight this but the facts are that you will probably be infected with something nasty. Please protect yourself, others around you and the public.

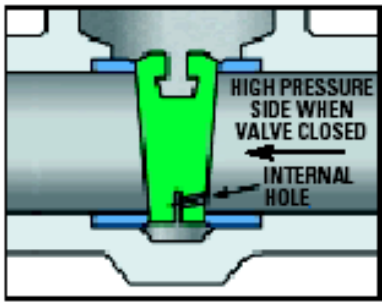
Notice the corrosion inside this cast iron main.

This corrosion is caused by chemical changes produced by electricity or electrolysis. We call this type of corrosion tuberculation. It is a protective crust of corrosion products that have built up over a pit caused by the loss of metal due to corrosion or electrolysis. This type of corrosion will decrease the C-Factor and the carrying capacity in a pipe. Crenothrix bacteria or Red-Iron bacteria will live in the bioslime in this type of tuberculation. Now for dealing with this nasty—there are two methods: the fast method, super chlorinate and flush for ever. Or, replace the line with a nice plastic water main. It is up to your Supervisor, but remember the nasty in the water. No one that knows about it will ever drink water from the house service. We need to do a better job.

Gate valve storage procedures. Always store a gate valve with the gate up or opened. Not like this picture. Sunlight will give the rubbers a good shot of Vitamin D and a sunburn, destroying the rubbers with ultraviolet radiation. I like to keep the valves covered and clean and I want you to do the same. I know that some of you don't care because these valves are so damn heavy and bother-some. Get over it and quit making $800.00 bird nests. We are professionals and must remember the final outcome. We provide drinking water to the public. Don't ever let me catch you doing this, or I'll throw you under the bus. Notice the two different styles of flange fittings.

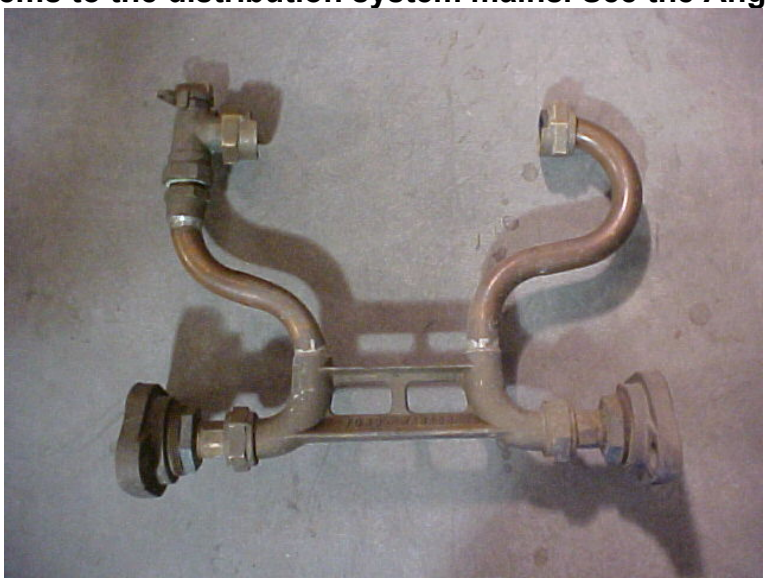
Knife Gate Valve

Always follow standard safety procedures when working on a valve. Install the valve so that the arrows on both sides of the body are in the direction of positive pressure differential.



The preferred orientation is with the stem vertical and the handwheel pointing up. The opposite orientation is not recommended, because fiber and dirt can build-up in the bonnet.

Service connections are used to connect individual buildings or other plumbing systems to the distribution system mains. See the Angle stop.



Water Meter Re-setter, riser or sometimes referred to as a copper yoke. There is also a cast iron version which isbest broken off with two sledge or cocking hammers when it's time to replace or retrofit the service. You almost always replace a yoke stop hot. A Yoke stop is an Angle Stop most of the time but I've seen a nasty galvanized valve that is also used in this situation.

Common distribution fittings: Single check, Poly Pig, 1 inch repair clamp, 4 inch full circle clamp, T- Bolt and a corp. and saddle. Note from Dr. Durbin, Single checks are not a backflow assembly and will probably stick open over time. I know that most systems will pay for these but unless you replace or test these checks, they will not hold up. Most fitting salesmen will not tell you this little tidbit. Notice the Corp, it is a ball type valve.

Ductile pipe Cement-lined iron pipe. I've seen thousands of dollars of pipe that is dropped or moved with the front bucket of a backhoe and destroyed. This destroys the interior protection of the pipe, causing leaks which will start in a few years. I know that some of you welcome this as job security. These nitwits need job security but water professionals do not need crappy work to keep them employed. Always protect and store all types of pipe covered in a pipe rack. This goes for the proper storage of rubbers as well.

Flex Coupling--sometimes referred to as a Dayton; used to join pipes or to "cut-in a valve." You will learn that you can use different sizes to join pipe or even file out the inside diameter to adjust to larger pipes like ACP. This flex coupling only has three bolts. I like four or more for work with larger pipe work. Dr. Durbin's trick, When working on a water line, I like to turn the valves on slowly to fill the water main as the flex couplings are being tightened. This allows the air to escape and for you to find leaks. It also allows debris in the main to flush out.

Here is a Four-Way pipe cutting tool used for iron pipe. Be careful not to break the wheels by over-tightening. I personally like 4-Ways because of the nice cut. You will learn to recognize the distinct snap of cut pipe. The only draw back to these cutters is cutting a small section out of the main. You may need to make two or three more cuts and break the section out with a cocking hammer. It will easily cut Ductile, Galvanized and even Plastic. Plastic pipe cutters utilize sharper cutting wheels. Rookies like to thread the pipe rather than cut the pipe. It is fun to watch and good to tease these rookies about it. Especially if they have just finished jumping a stop with the valve closed or no ball. Good times for sure in the crazy Distribution field.

Picture on right, difficult to see, these are pipe crimpers. These will easily and effectively stop flow in copper or plastic pipe in tubing less than 2 inches. The only problem is dealing with the crimp when you are finished. I suggest placing a flex coupling over the crimp in plastic and completely cutting the crimped area out when done in copper pipe.

Top picture, two gate valves blew out, you can see the kickers or thrust blocks in the back ground. Bottom picture, a tapping machine and a new gate valve. These tapping machines are very, very expensive. I can't believe the cost of a new one. Even buying a used one will set you back more than a new car.

Common Rotary Valves

Globe Valve *Rotary Valve*

Primarily used for flow regulation, and works similar to a faucet. They are rare to find in most distribution systems but can be found at treatment plants. Always follow standard safety procedures when working on a valve.

Most Globes have compact OS & Y type, bolted bonnet, rising stems, with renewable seat rings. The disc results with most advanced design features provide the ultimate in dependable, economical flow control.

Globe valves should usually be installed with the inlet below the valve seat. For severe throttling service, the valve may be installed so that the flow enters over the top of the seat and goes down through it. Note that in this arrangement, the packings will be constantly pressurized. If the valve is to be installed near throttling service, verify with an outside contractor or a skilled valve technician. Globe valves per se are not suitable for throttling service.

Various Globe Valves

The valve should be welded onto the line with the disc in the fully closed position. Leaving it even partially open can cause distortion and leaking. Allow time for the weld to cool before operating the valve the first time in the pipeline.

The preferred orientation of a globe valve is upright. The valve may be installed in other orientations, but any deviation from vertical is a compromise. Installation upside down is not recommended because it can cause dirt to accumulate in the bonnet.

Globe Valve Problems and Solutions

If the valve stem is improperly lubricated or damaged-- Disassemble the valve and inspect the stem. Acceptable deviation from theoretical centerline created by joining center points of the ends of the stem is 0.005"/ft of stem. Inspect the threads for any visible signs of damage.

Small grooves less than 0.005" can be polished with an Emory cloth. Contact specialized services or an outside contractor if run-out is unacceptable or large grooves are discovered on the surface of the stem.

If the valve packing compression is too tight--Verify the packing bolt torque and adjust if necessary.

Foreign debris is trapped on threads and/or in the packing area--This is a common problem when valves are installed outdoors in sandy areas and area not cleaned before operating.

Always inspect threads and packing area for particle obstructions; even seemingly small amounts of sand trapped on the drive can completely stop large valves from cycling. The valve may stop abruptly when a cycle is attempted. With the line pressure removed from the valve, disconnect the actuator, gear operator or handwheel and inspect the drive nut, stem, bearings and yoke bushing. Contaminated parts should be cleaned with a lint-free cloth using alcohol, varsol or equivalent. All parts should be re-lubricated before being re-assembled. If the valves are installed outdoors in a sandy area, it may be desirable to cover the valves with jackets.

If the valve components are faulty or damaged--contact specialized services or an outside contractor.

If the valve's handwheel is too small--Increasing the size of the handwheel will reduce the amount of torque required to operate the valve. If a larger handwheel is installed, the person operating the valve must be careful not to over-torque the valve when closing it.

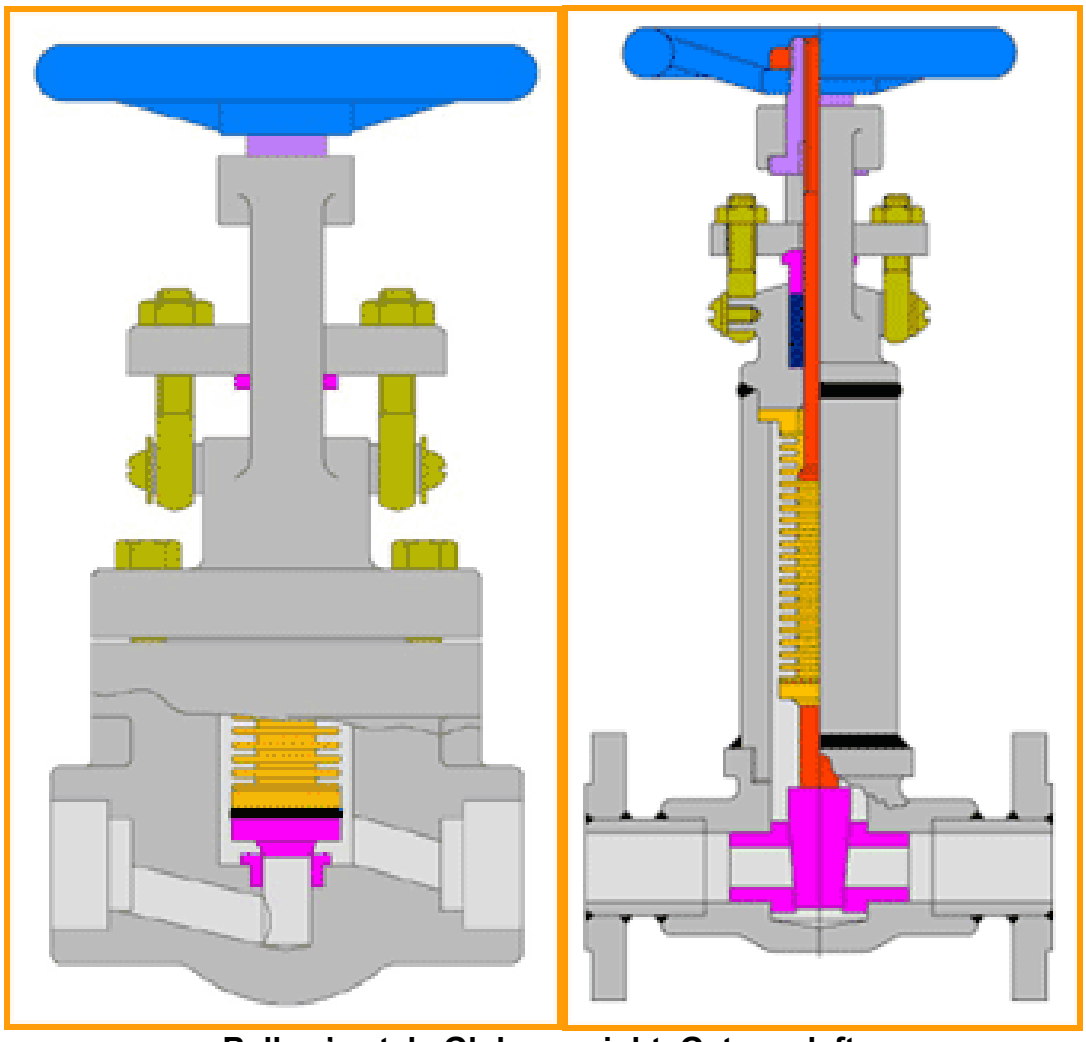
Bellow Seal Valve

Always follow standard safety procedures when working on a valve.

Bellows seal valves provide a complete hermetic seal of the working fluid. They are used in applications where zero leakage of the working fluid into the environment is permitted.

Bellows seal valves are specially modified versions of the standard valves. The installation information that applies to gate and globe valves will apply to bellows seal valves.

A packing leak signifies that the bellows has ruptured or the bellows-assembly weld has a crack. Dr. Durbin does not recommend repairing or reusing a damaged bellows. Instead, Dr. Durbin suggests replacing the entire bonnet assembly including bellows and stem.



Bellow's style Globe on right, Gate on left.

Pressure Sustaining Valve

Pressure sustaining valves are used to sustain the system pressure to a predetermined maximum level. The applications balance the pressure distribution throughout the whole system by maintaining the minimum pressure for high altitude users. Pressure sustaining valves are also used to prevent discharging of the pipe system when any user starts to operate. More in a few more pages.

Pressure Reducing Valve

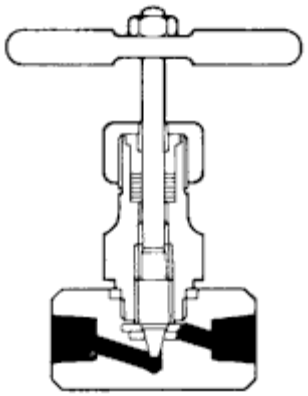
Pressure reducing valves maintain a predetermined outlet pressure which remains steady and unaffected by either changing of inlet pressure and/or various demands. Pressure Reducing Valves are self contained control valves which do not require external power. More in a few more pages.

Insertion Valves *Rotary Valve*

You know sometimes you can obtain a shut down and you have two choices. Do it hot or cut in an insertion or inserting valve. An Insertion valve is normally a Gate Valve that is made to be installed on a hot water main. A few years ago, this was a serious feat. First, you had to pour ten yards of mud or cement and come back and cut the valve in. No longer. The Insertion valve machine and tap works like a tapping sleeve. The only difference is that the tap points up and not to the side. I recommend that any major system budget money to purchase this equipment. It will pay for itself on the first job. Otherwise, contract the work out. You can see in the picture a manually operated tapping machine. I prefer the electric. Note: see the sweet shoring shield set-up. It is rare to see a nice shoring job.

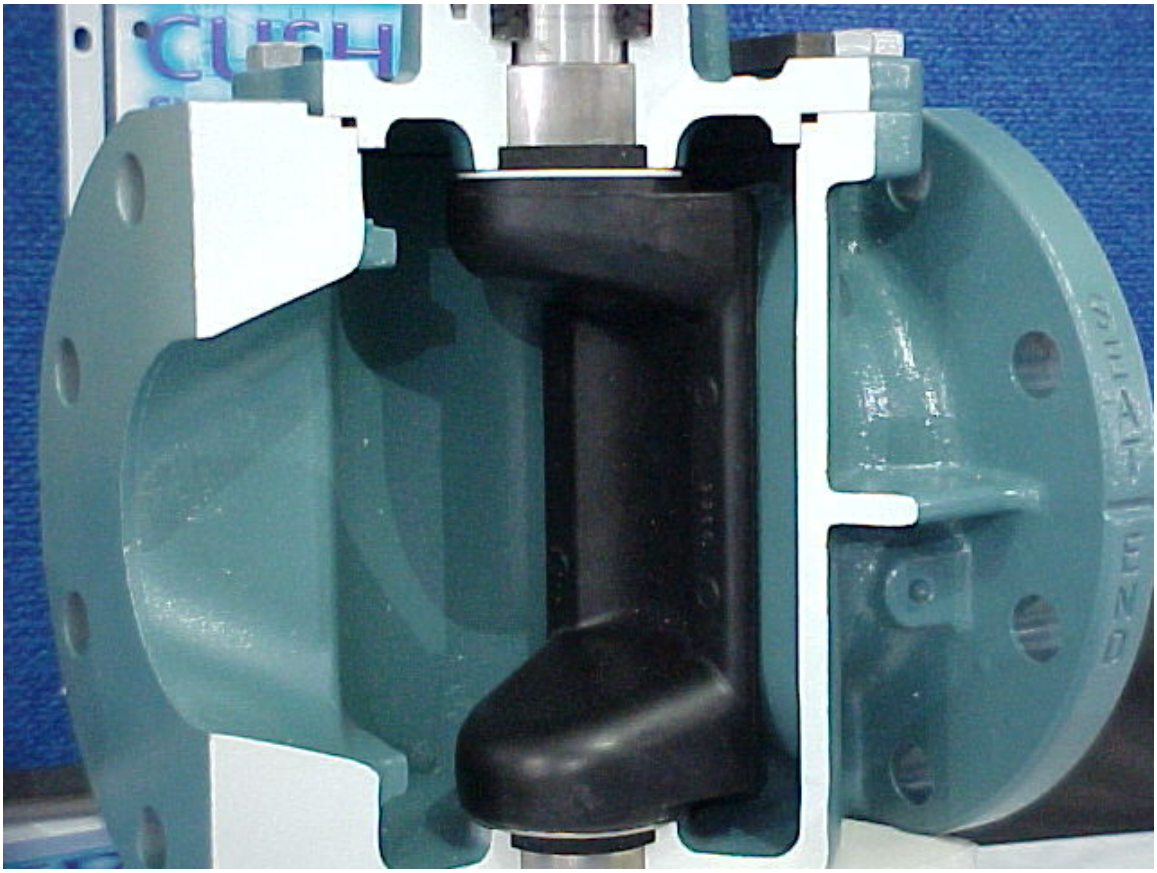
Needle Valves *Rotary Valve*

A needle valve, as shown on the right, is used to make relatively fine adjustments in the amount of fluid flow. The distinguishing characteristic of a needle valve is the long, tapered, needle- like point on the end of the valve stem. This "needle" acts as a disk. The longer part of the needle is smaller than the orifice in the valve seat and passes through the orifice before the needle seats. This arrangement permits a very gradual increase or decrease in the size of the opening. Needle valves are often used as component parts of other, more complicated valves. For example, they are used in some types of reducing valves.



Plug Valves *Rotary Valve*

Plug valves are extremely versatile valves that are found widely in low-pressure sanitary and industrial applications, especially petroleum pipelines, chemical processing and related fields, and power plants. They are high capacity valves that can be used for directional flow control, even in moderate vacuum systems. They can safely and efficiently handle gas and liquid fuel, and extreme temperature flow, such as boiler feed water, condensate, and similar elements. They can also be used to regulate the flow of liquids containing suspended solids (slurries).



Cut-away of a Plug Valve

Angle Stops *Rotary Valve*

When working in tight areas, you sometimes need a tight fitting valve. This is an excellent place for an Angle Stop or Angle valve. If you ever have to jump an Angle valve on hot, first dismantle the bottom compression fitting and the rubber and slide it on the water line. Sometimes the bottom compression fitting will have a set-screw and some operators like to tighten it to the pipe or service before jumping the stop. Either way, it will work. Always have a helper if jumping any service larger than 1 inch.

Get in there and jump that corp!

Ball or Corporation Stop *Rotary Valve* ***Small Valves 2 inches and smaller***

Most commonly found on customer or water meters. All small backflow assemblies will have two Ball valves. It is the valve that is either fully on or fully off; and the one that you use to test the abilities of a water service rookie. The best trick is to remove the ball from the Ball valve and have a rookie *Jump a Stop*. The Corp is usually found at the water main on a saddle. Some people say that the purpose of the Corp is to regulate the service. I don't like that explanation. No one likes to dig up the street to regulate the service and Ball valves are only to be used fully on or fully off.

Most ball valves are the quick-acting type. They require only a 90-degree turn to either completely open or close the valve. However, many are operated by planetary gears. This type of gearing allows the use of a relatively small handwheel and operating force to operate a fairly large valve. Always follow standard safety procedures when working on a valve.

The gearing does, however, increase the operating time for the valve. Some ball valves also contain a swing check located within the ball to give the valve a check valve feature. The brass ball valve is often used for house appliance and industry appliance, the size range is 1/4"-4". Brass or zinc is common for body, brass or iron for stem, brass or iron for ball, aluminum, stainless steel, or iron for handle including a Teflon seal in the ball housing. Flush the pipeline before installing the valve. Debris allowed to remain in the pipeline (such as weld spatters, welding rods, bricks, tools, etc.) can damage the valve. After installation, cycle the valve a minimum of three times and re-torque bolts as required. Ensure that the valve is in the open position and the inside of the body bore of the valve body/body end is coated with a suitable spatter guard.

Bird's eyed view of the coveted stainless steel ball.

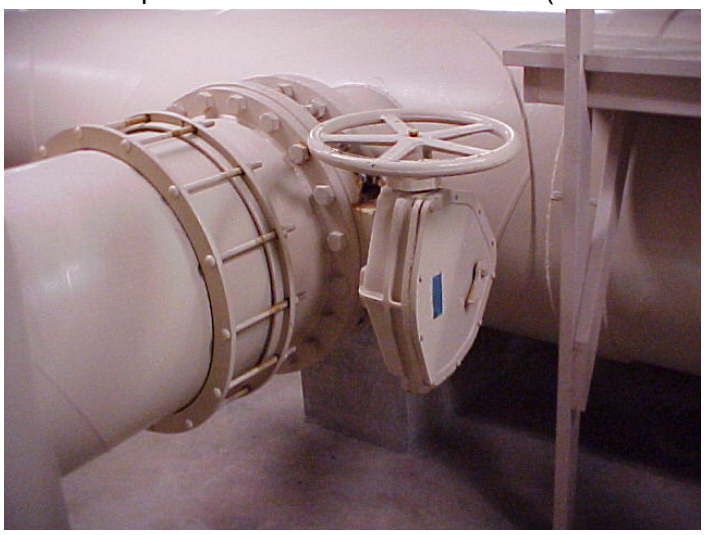
Removing the ball is very difficult. I think they use a robot to tighten the rear nut to keep you from removing it. I recommend that you always use pipe dope or Teflon tape when installing a Stop. I know a lot of you think that brass or bronze will make up the slack, but pipe dope, or Teflon dope or tape makes a nicer job and makes for an easier removal.

Butterfly Valve *Rotary Valve*

Usually a huge water valve found in both treatment plants and through out the distribution system. If the valve is not broken, it is relatively easy to operate. It is usually accompanied with a Gate valve used as a by-pass to prevent water hammer. When I was a Valve man, it seemed that every Bypass valve was broken closed when near a Butterfly valve.

These are rotary type of valves usually found on large transmission lines. They may also have an additional valve beside it known as a "***bypass***" to prevent a water hammer.

Some of these valves can require 300-600 turns to open or close. Most Valvemen (or the politically correct term Valve Operators) will use a machine to open or close a Butterfly Valve. The machine will count the turns required to open or close the valve.

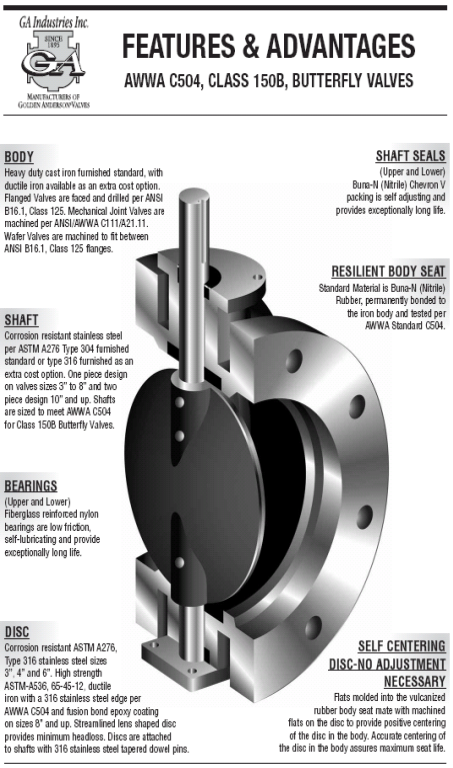


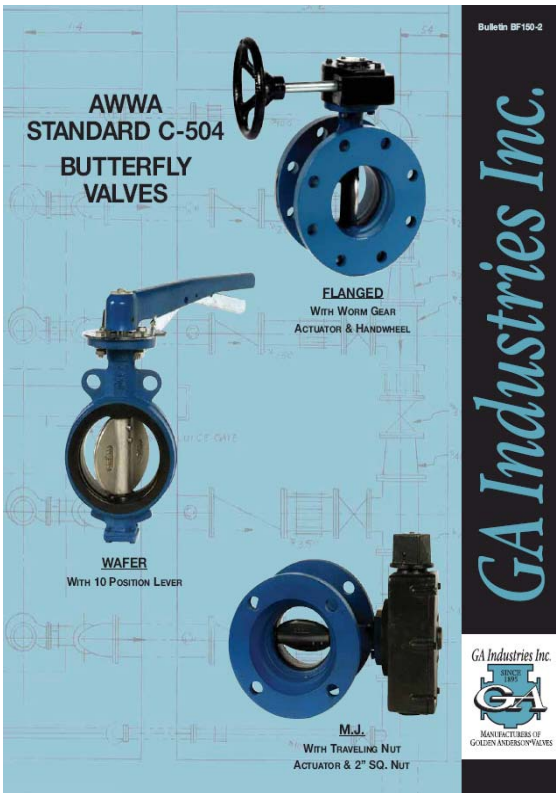
Butterfly valves should be installed with the valve shaft horizontal or inclined from vertical. Always follow standard safety procedures when working on a valve.

The valve should be mounted in the preferred direction, with the "HP" marking. Thermal insulation of the valve body is recommended for operating temperatures above 392°F (200°C). The valve should be installed in the closed position to ensure that the laminated seal in the disc is not damaged during installation.

If the pipe is lined, make sure that the valve disc does not contact the pipe lining during the opening stroke. Contact with lining can damage the valve disc.

54 inch Butterfly valve on a huge transmission line. Nice job but no shoring or valve blocking. Don't let me catch you doing this, or I'll throw you in the back of the bus.





ACTUATION METHODS

- Standard Handwheel
- Chainwheel Operated
- Square Nut
- Pneumatic
- Electric

Butterfly Valve Problems

A butterfly valve may have jerky operation for the following reasons:

If the packing is too tight--Loosen the packing torque until it is only hand tight. Tighten to the required level and then cycle the valve. Re-tighten, if required. CAUTION: Always follow safety instructions when operating on valve.

If the shaft seals are dirty or worn out--Clean or replace components, as per assembly-disassembly procedure. CAUTION: Always follow safety instructions when operating on a valve.

If the shaft is bent or warped--The shaft must be replaced. Remove valve from service and contact an outside contractor or your expert fix it person.

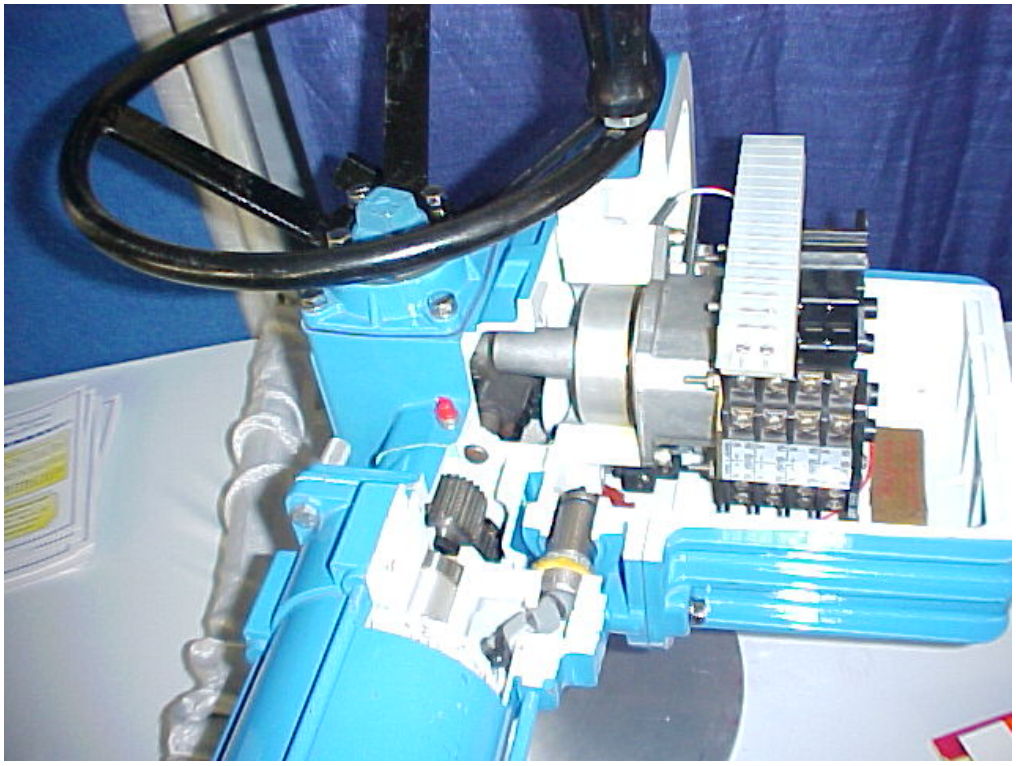
If the valve has a pneumatic actuator, the air supply may be inadequate--Increase the air supply pressure to standard operating level. Any combination of the following may prevent the valve shaft from rotating:

If the actuator is not working--Replace or repair the actuator as required. Please contact specialized services or an outside contractor for assistance.

If the valve is packed with debris--Cycle the valve and then flush to remove debris. A full cleaning may be required if flushing the valve does not improve valve shaft rotation. Flush or clean valve to remove the debris.

A broken 54 inch Butterfly and a worker inside the water main preparing the interior surface. Notice, this is a Permit Required Confined Space. Hot work permit is also required. Don't let me catch you, or I'll drive over you with my bus. Side note, there is a plastic version of the 54 and 60 inch Butterfly valve.

Here at a water treatment plant, we can see both valve actuators control devices and Butterfly valves as well. Bottom picture is a cut-away of an actuator.



Actuators and Control Devices

Directional control valves route the fluid to the desired actuator. They usually consist of a spool inside a cast iron or steel housing. The spool slides to different positions in the housing, and intersecting grooves and channels route the fluid based on the spool's position.

The spool has a central (neutral) position maintained with springs; in this position the supply fluid is blocked, or returned to tank. Sliding the spool to one side routes the hydraulic fluid to an actuator and provides a return path from the actuator to the tank. When the spool is moved to the opposite direction, the supply and return paths are switched. When the spool is allowed to return to the neutral (center) position the actuator fluid paths are blocked, locking it in position.

Directional control valves are usually designed to be stackable, with one valve for each hydraulic cylinder, and one fluid input supplying all the valves in the stack.

Tolerances are very tight in order to handle the high pressure and avoid leaking; spools typically have a clearance with the housing of less than a thousandth of an inch. The valve block will be mounted to the machine's frame with a three point pattern to avoid distorting the valve block and jamming the valve's sensitive components.

The spool position may be actuated by mechanical levers, hydraulic pilot pressure, or solenoids which push the spool left or right. A seal allows part of the spool to protrude outside the housing, where it is accessible to the actuator.

The main valve block is usually a stack of off the shelf directional control valves chosen by flow capacity and performance. Some valves are designed to be proportional (flow rate proportional to valve position), while others may be simply on-off. The control valve is one of the most expensive and sensitive parts of a hydraulic circuit.

Pressure relief valves are used in several places in hydraulic machinery: on the return circuit to maintain a small amount of pressure for brakes, pilot lines, etc; on hydraulic cylinders, to prevent overloading and hydraulic line/seal rupture; on the hydraulic reservoir, to maintain a small positive pressure which excludes moisture and contamination.

Pressure reducing valves reduce the supply pressure as needed for various circuits.
Sequence valves control the sequence of hydraulic circuits; to insure that one hydraulic cylinder is fully extended before another starts its stroke, for example.

Shuttle valves provide a logical function.

Check valves are one way valves, allowing an accumulator to charge and maintain its pressure after the machine is turned off, for example.

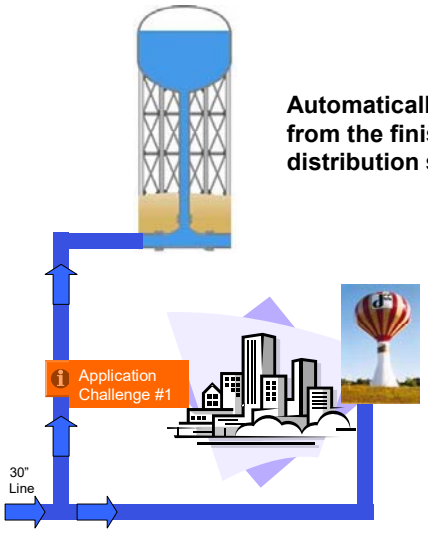
Pilot controlled Check valves are one way valves that can be opened (for both directions) by a foreign pressure signal. For instance, if the load should not be held by the check valve anymore. Often the foreign pressure comes from the other pipe that is connected to the motor or cylinder.

Counterbalance valves. A counterbalance valve is, in fact, a special type of pilot controlled checkvalve. Whereas the checkvalve is open or closed, the counterbalance valve acts a bit like a pilot controlled flow control.
Cartridge valves are, in fact, the inner part of a check valve; they are off the shelf components with a standardized envelope, making them easy to populate a proprietary valve block. They are available in many configurations: on/off, proportional, pressure relief, etc. They generally screw into a valve block and are electrically controlled to provide logic and automated functions.
Hydraulic fuses are in-line safety devices designed to automatically seal off a hydraulic line if pressure becomes too low, or safely vent fluid if pressure becomes too high.

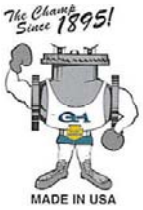
Auxiliary valves. Complex hydraulic systems will usually have auxiliary valve blocks to handle various duties unseen to the operator, such as accumulator charging, cooling fan operation, air conditioning power, etc... They are usually custom valves designed for a particular machine, and may consist of a metal block with drilled ports and channels. Cartridge valves are threaded into the ports and may be electrically controlled by switches or a microprocessor to route fluid power as needed.

Here is an Operator who can utilize electronic or SCADA control of the valves at a modern treatment facility. Push a button and live a good life. This is one of my favorite students of all time. He has been coming to TLC classes for ten years and has climbed all the way to the top. I am very proud of his work as well as that of all my students.

Water Distribution System Application Challenge #1



Automatically improve the pumping efficiency from the finished water pump station to the distribution system in a long pipeline..



Proposed Solution:

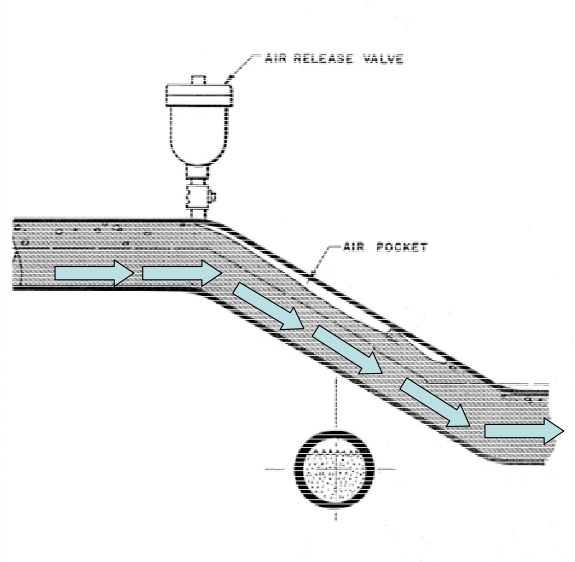
Automatic Air Valves

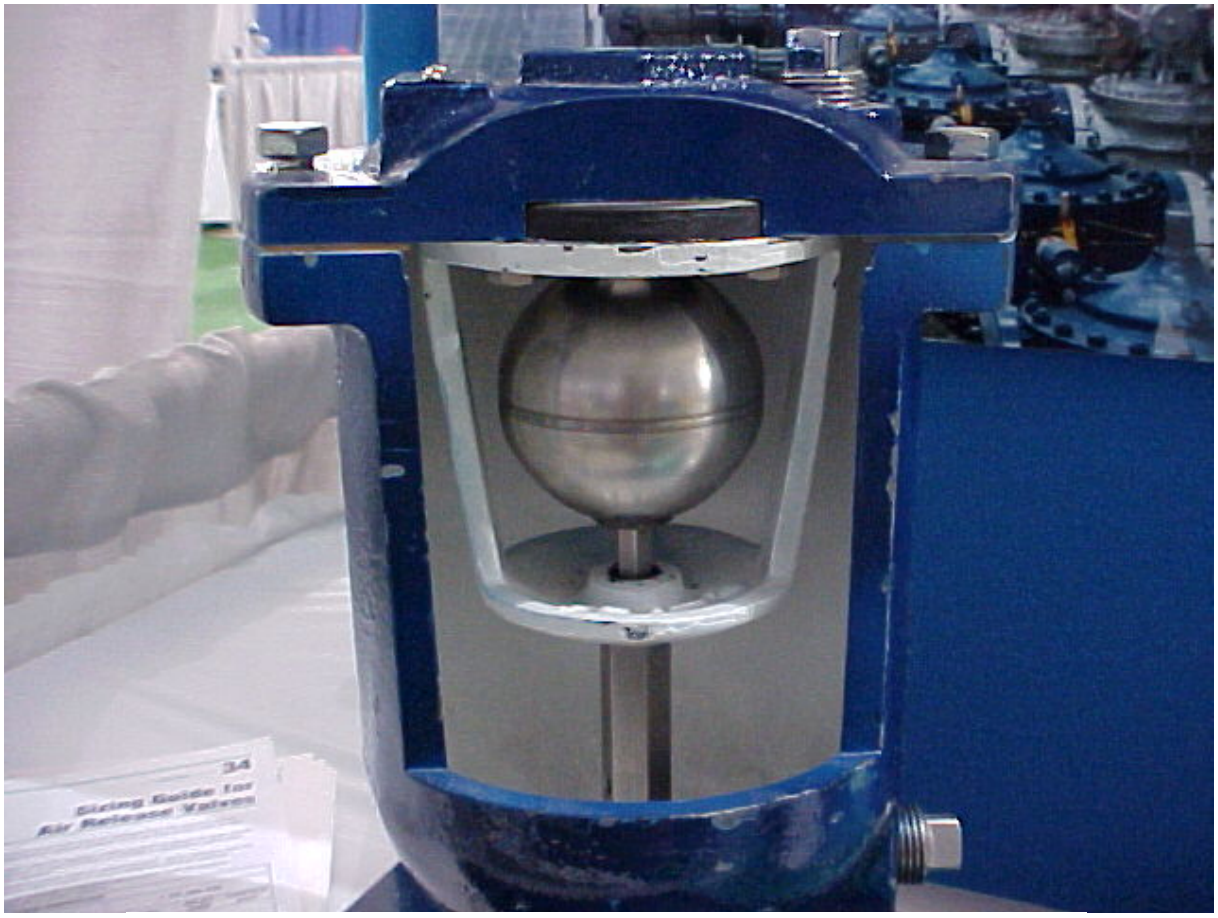
Why use automatic air valves?

- ❑ **Increase flow capacity**
- ❑ **Reduce pumping costs (less electricity)**
- ❑ **Lessen the effect of water hammer.**
- ❑ **Prevent vacuum damage, such as pipeline collapse, seal failure, contamination and cross connection.**
- ❑ **Keep the lines full to reduce corrosion of the pipe.**

Air pockets reduce the cross sectional area of the pipe available to transmit the fluid, similar to partially closed valves. The velocity will increase at all air pockets and therefore the system head loss also increases.

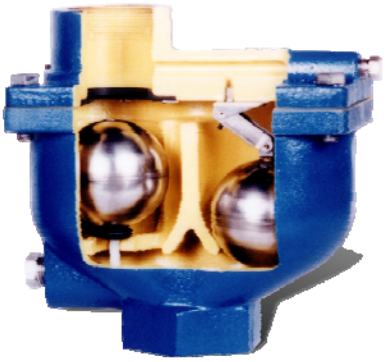
The flow in the pipeline will push the air pocket down the pipe. The location of air valves should be at the point of the anticipated air pocket during flowing conditions.



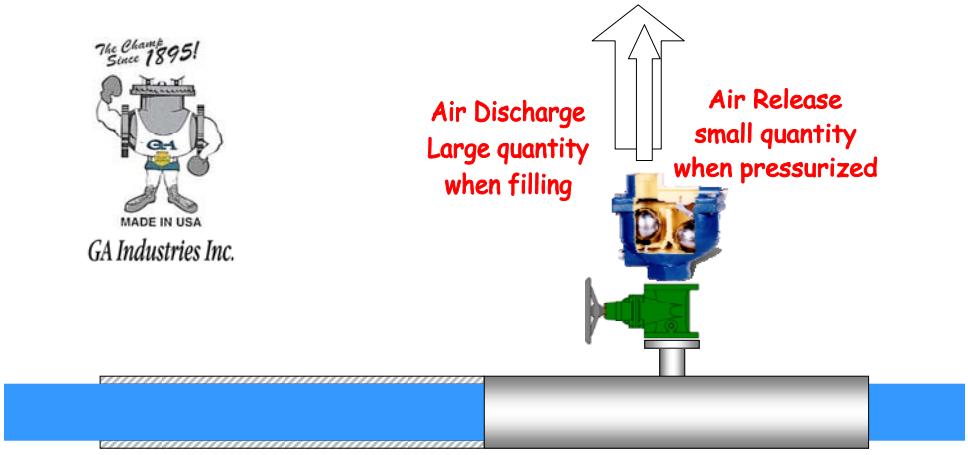


COMBINATION AIR VALVES

Performs functions of both the small orifice air release and large orifice air/vacuum valve



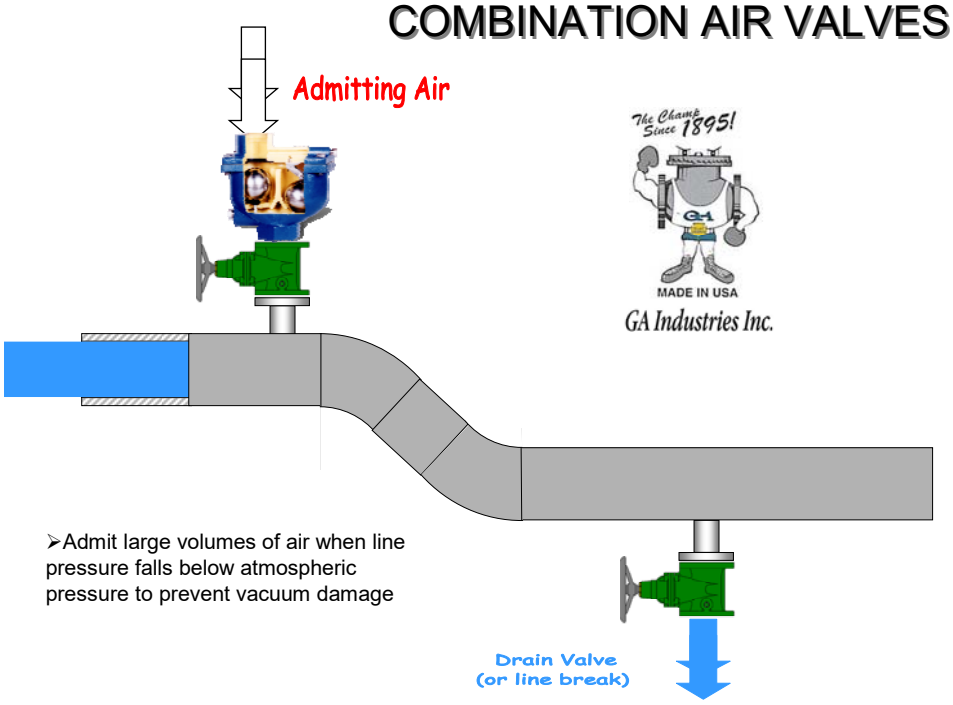
COMBINATION AIR VALVES



➢Purge large volumes of air while filling the pipe.

➢Release small pockets of air during system operation when pipeline is pressurized.

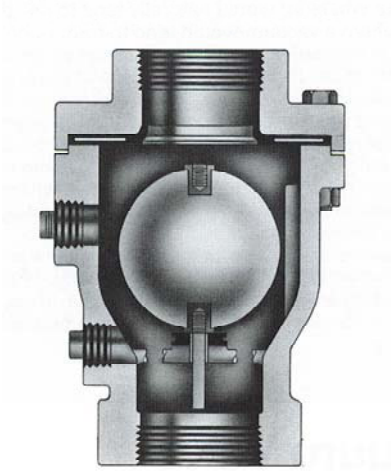
COMBINATION AIR VALVES



➢Admit large volumes of air when line pressure falls below atmospheric pressure to prevent vacuum damage

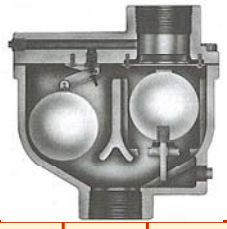
AIR / VACUUM VALVES

- **Exhaust air as water fills the pipe; closes when the pipe is full and water enters the valve lifting the float against the seat.**
- **Does not reopen unless the line pressure falls below atmospheric pressure due to a line break or pipeline draining. The float drops and air is admitted into the pipe to minimize vacuum formation.**
- **The large size outlet orifice (normally equal to the inlet orifice) sized about 1/6th to 1/8th of the nominal pipe size to purge air and relieve vacuum.**
- **Locate at high points and between the pump and check valve.**



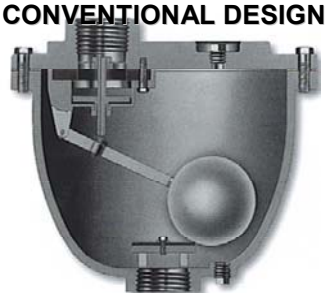
KINETIC vs. CONVENTIONAL COMBINATION AIR VALVES

KINETIC DESIGN



Size	Length	Width	Height	Weight
1”	6-1/4”	3-7/8”	7-1/4”	16 Lb
2”	9”	4-3/4”	9-3/8”	30 Lb
3”	12-3/8”	6-5/8”	12-1/4”	65 Lb
4”	15-1/4”	8-1/4”	13-1/4”	120 Lb

CONVENTIONAL DESIGN

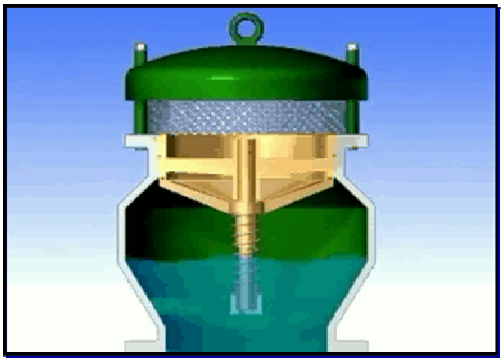


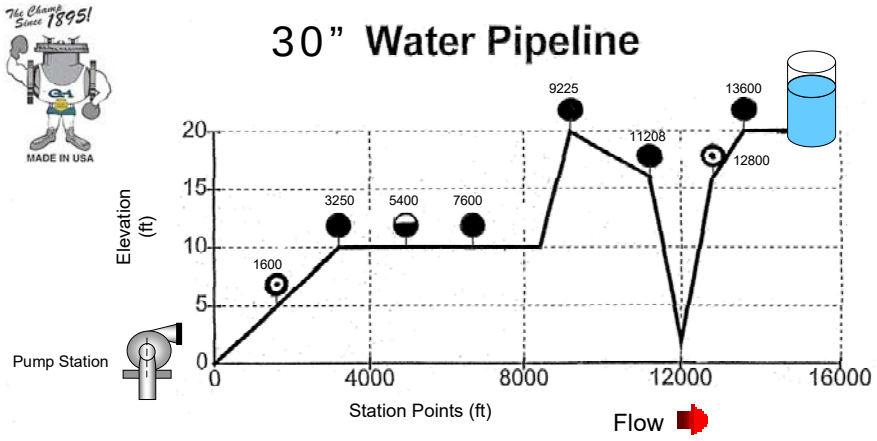
Size	Length	Width	Height	Weight
1”	11”	7”	10”	35 Lb
2”	14”	8”	12-1/4”	75 Lb
3”	16”	10”	15-1/2”	100 Lb
4”	18”	11”	17”	170 Lb

Vacuum Breaking Valves

SILENT CHECK TYPE

- Normally closed.
- Opens to admit air when pipe vacuum exceeds spring.
- Re-closes when pipe pressure returns to atmospheric.
- Can be supplied with small orifice for slow air release.





- Air Release- **Locate at high points and at ¼ to ½ mile intervals along long lengths of pipe**
- Air/Vacuum- **Locate at high points, between pump and check valve, long ascents, change in slope**
- Combination **- Locate at high points, long ascents, long descents, change in slope**

Hint: If your not sure what type of air valve is required, use a combination valve. It won't hurt anything and does not cost much more.

Pressure Reducing Valves *Rotary Valve*

Pressure Relief Valve

Pressure relief valves are used to release excess pressure that may develop as a result of a sudden change in the velocity of the water flowing in the pipe.

PRVs assist in a variety of functions, from keeping system pressures safely below a desired upper limit to maintaining a set pressure in part of a circuit. Types include relief, reducing, sequence, counterbalance, and unloading. All of these are normally closed valves, except for reducing valves, which are normally open. For most of these valves, a restriction is necessary to produce the required pressure control. One exception is the externally piloted unloading valve, which depends on an external signal for its actuation.

The most practical components for maintaining secondary, lower pressure in a hydraulic system are pressure-reducing valves. Pressure-reducing valves are normally open, 2-way valves that close when subjected to sufficient downstream pressure. There are two types: direct acting and pilot operated.

Direct acting - A pressure-reducing valve limits the maximum pressure available in the secondary circuit regardless of pressure changes in the main circuit, as long as the work load generates no back flow into the reducing valve port, in which case the valve will close.

The pressure-sensing signal comes from the downstream side (secondary circuit). This valve, in effect, operates in reverse fashion from a relief valve (which senses pressure from the inlet and is normally closed). As pressure rises in the secondary circuit, hydraulic force acts on area A of the valve, closing it partly. Spring force opposes the hydraulic force, so that only enough oil flows past the valve to supply the secondary circuit at the desired pressure. The spring setting is adjustable.

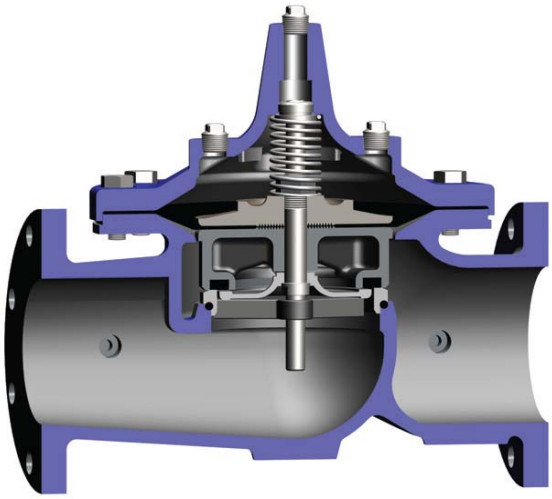
When outlet pressure reaches that of the valve setting, the valve closes, except for a small quantity of oil that bleeds from the low-pressure side of the valve, usually through an orifice in the spool, through the spring chamber, to the reservoir. Should the valve close fully, leakage past the spool could cause pressure build-up in the secondary circuit. To avoid this, a bleed passage to the reservoir keeps it slightly open, preventing a rise in downstream pressure above the valve setting. The drain passage returns leakage flow to reservoir. (Valves with built-in relieving capability also are available to eliminate the need for this orifice.)

Constant and fixed pressure reduction - Constant-pressure-reducing valves supply a preset pressure, regardless of main circuit pressure, as long as pressure in the main circuit is higher than that in the secondary. These valves balance secondary-circuit pressure against the force exerted by an adjustable spring which tries to open the valve. When pressure in the secondary circuit drops, spring force opens the valve enough to increase pressure and keep a constant reduced pressure in the secondary circuit. Fixed pressure reducing valves supply a fixed amount of pressure reduction regardless of the pressure in the main circuit. For instance, assume a valve is set to provide reduction of 250 psi. If main system pressure is 2,750 psi, reduced pressure will be 2,500 psi; if main pressure is 2,000 psi, reduced pressure will be 1,750 psi.

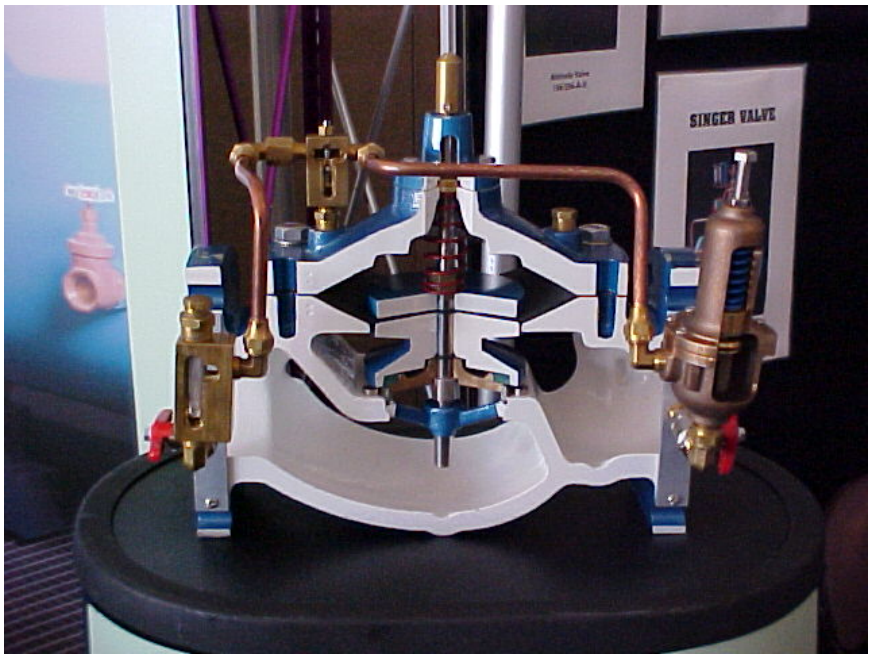
This valve operates by balancing the force exerted by the pressure in the main circuit against the sum of the forces exerted by secondary circuit pressure and the spring. Because the pressurized areas on both sides of the poppet are equal, the fixed reduction is that exerted by the spring.

How do Pressure Relief Valves Operate?

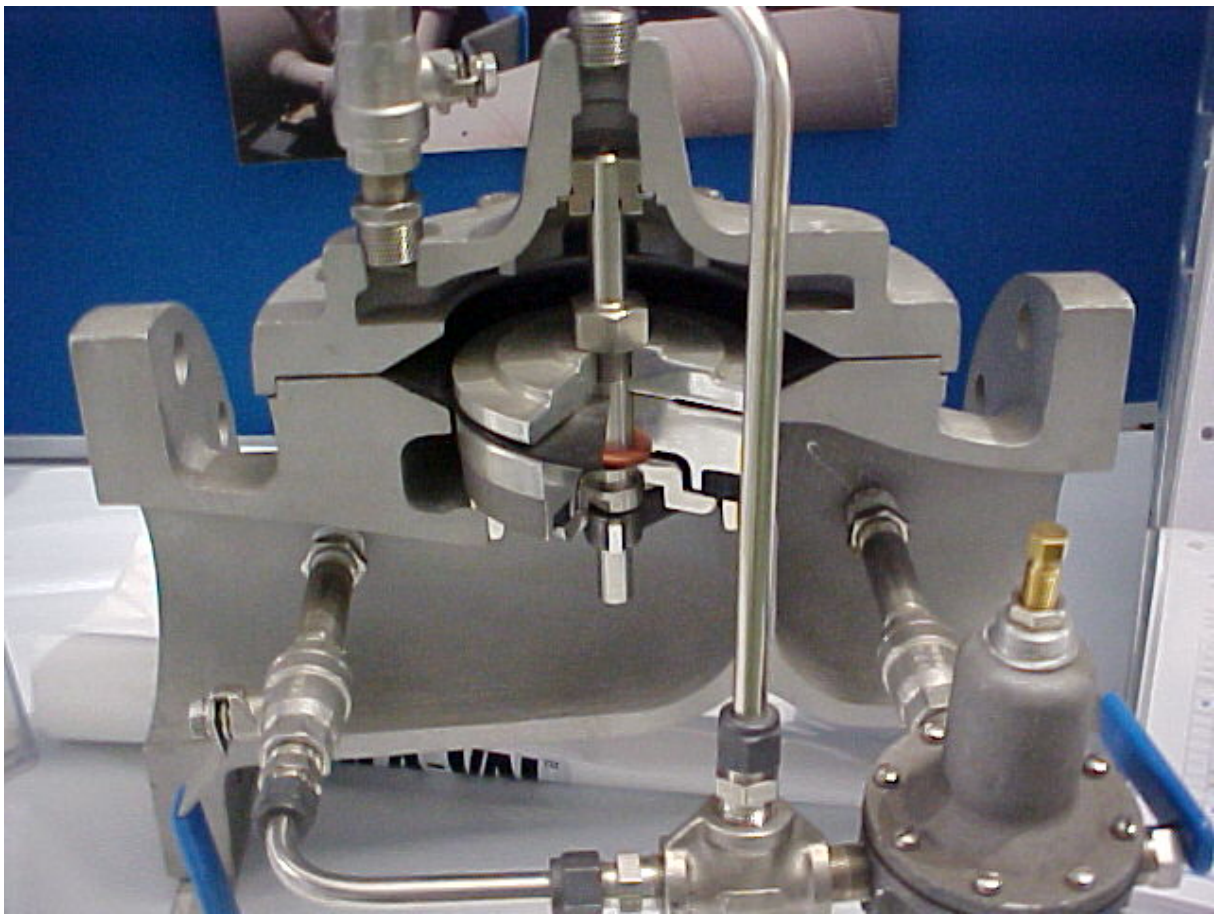
Most pressure relief valves consist of a main valve and pilot control system. The basic main Cla-Val valve is called a Hytrol Valve.

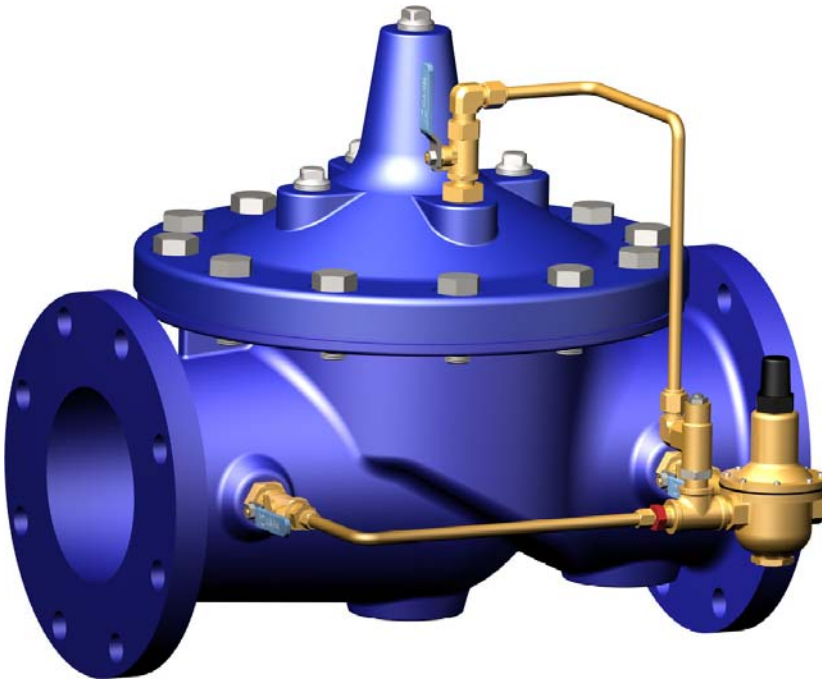


When no pressure is in the valve, the spring and the weight of the diaphragm assembly hold the valve closed.

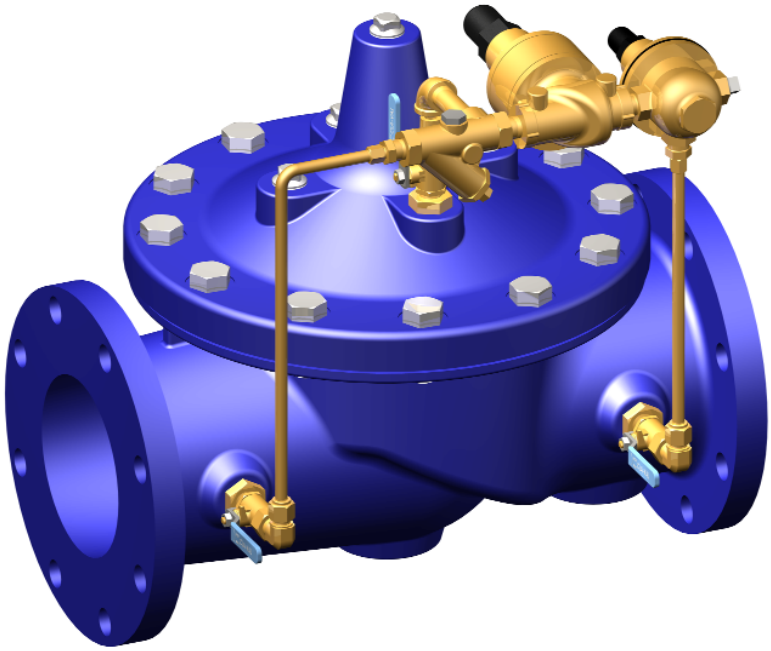


Often a small box can be connected to an existing pilot PRV valve to control the main Pressure Reducing Valve on the pipe network. This single box contains both the control electronics and an integral data logger to save the cost and space of having both a controller and a separate data logger. There are basically two types of PRV controllers, either time-based (to reduce the pipe pressure at low demand times, e.g. at night) or flow modulated controllers which can realize leakage savings throughout the day and night (by adjusting the pressure according to the demand to prevent excessive pressure at any time of the day or night).

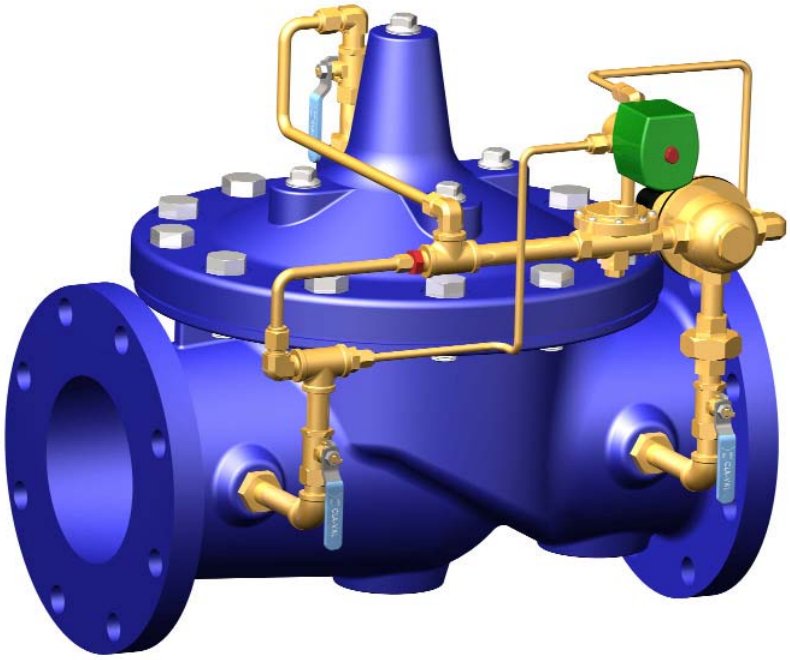




Pressure Reducing Valve Cla-Val 90 Series
• Holds downstream pressure to a pre-determined limit.
• Optional check feature.
• Fully supported frictionless diaphragm.



Pressure Reducing/Pressure Sustaining Control Valve Cla-Val 92 Series
• Maintains downstream pressure regardless of fluctuating demand and sustains upstream pressure to a pre-set minimum.
• Optional check feature.

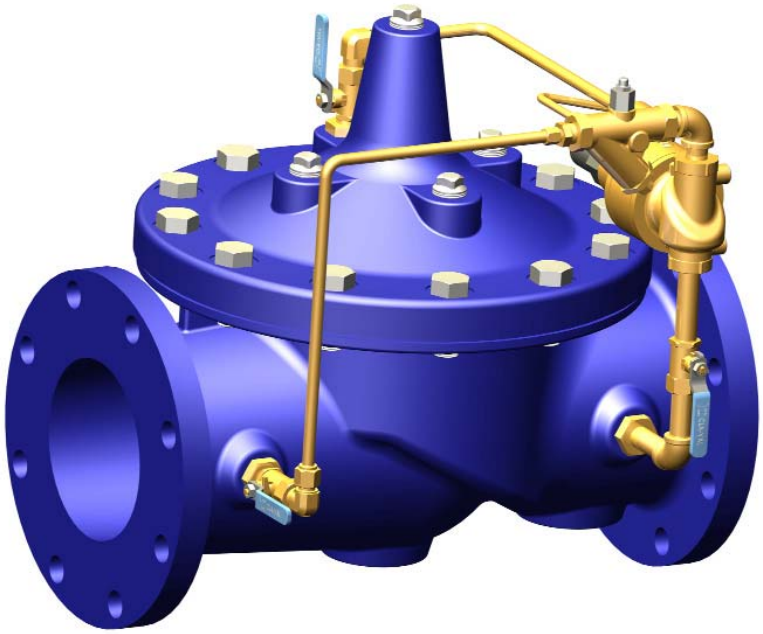


Pressure Reducing & Solenoid Shut-Off Valve Cla-Val 93 Series

• Ideal for reducing high transmission line pressures to lower distribution system pressures.
• Solenoid can be remotely activated.

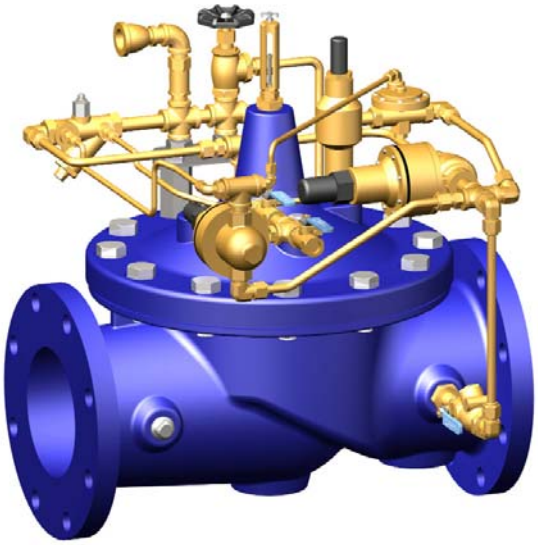
Pressure Reducing & Surge Control Valve Cla-Val 94 Series

• Integral surge pilot opens to prevent rapid pressure increases.
• Optional check feature.



Pressure Relief/Pressure Sustaining Valve Cla-Val 50 Series

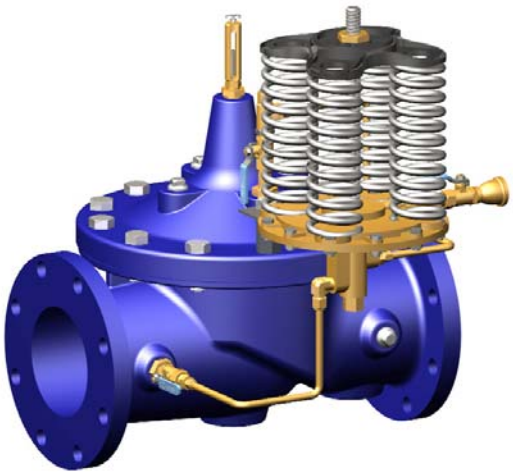
- Completely automatic operation.
- Accurate pressure control.
- Fast opening maintains line pressure.
- Slow closing prevents surges.
- Optional check feature.



Surge Anticipator Valve Cla-Val 52 Series

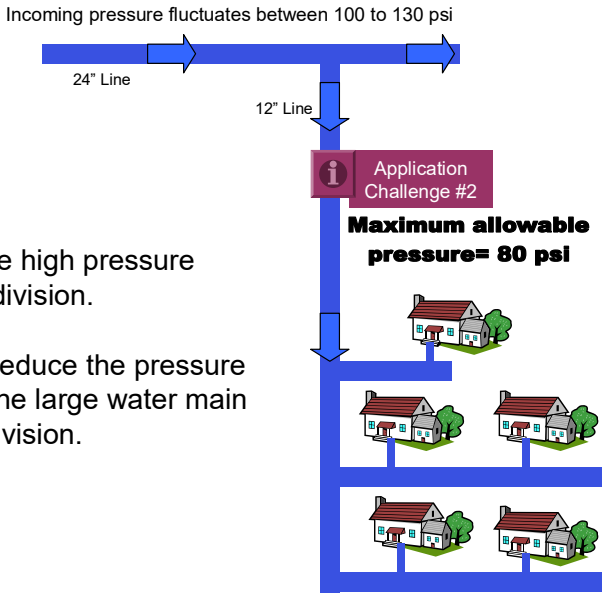
- Protects pumping equipment and pipelines from damage caused by rapid flow velocity changes.
- Opens on initial low pressure wave.
- Closes slowly to prevent subsequent surges.

Float Valve Cla-Val 124 Series
• Accurate and repeatable level control in tanks to pre-set high and low points
• Reliable drip-tight shut-off.
• On-Off non-modulating action.
• Use Model 428-01 for modulating service.



Altitude Control Valve Cla-Val 210 Series
• Provides accurate and repeatable tank level control.
• Optional check valve feature.
• Delayed opening option available.
• One-way and two-way flow pilot systems available.

Water Distribution System Application Challenge #2

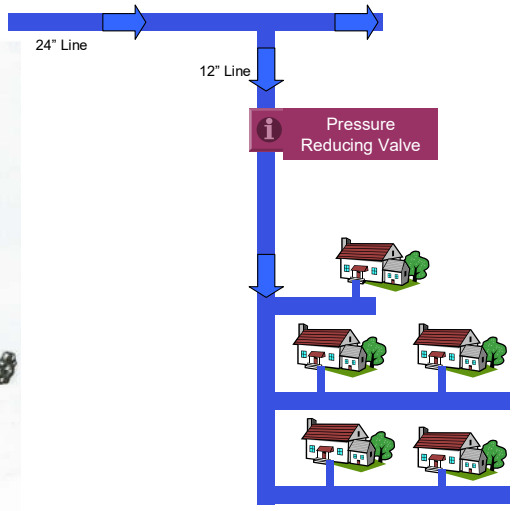


A small branch line tee's off a large high pressure water main to feed water to a subdivision.

Automatically (without electricity) reduce the pressure from a range of 100 to 130 psi in the large water main to not exceed 80 psi into the subdivision.

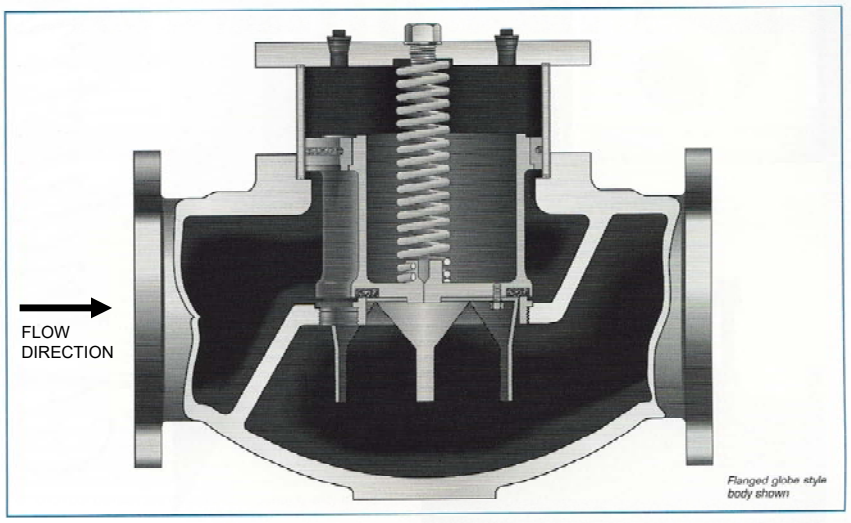
Proposed Solution

A Pressure Reducing Valve will reduce a higher variable upstream pressure to a uniform maximum downstream pressure by throttling in response to changes in the downstream pressure which result from changes in flow demand.



SERIES 2000 Features

1. Full-ported for high capacity
2. Stainless trim - Standard
3. Stainless steel vee-ports for precise low flow control
4. 1-$^1/_2$" through 3" - Screwed NPT connections
   2" through 12"- 125# Flanged connections
5. Globe or angle body, both use identical internal parts
6. Only one moving part
7. No rubber diaphragms to fatigue, rot, rupture or fail.
8. Drop-tight closure
9. Streamlined body for low inherent headloss
10. 100% tested for reliability
11. Easily maintained in the line
12. Many options available



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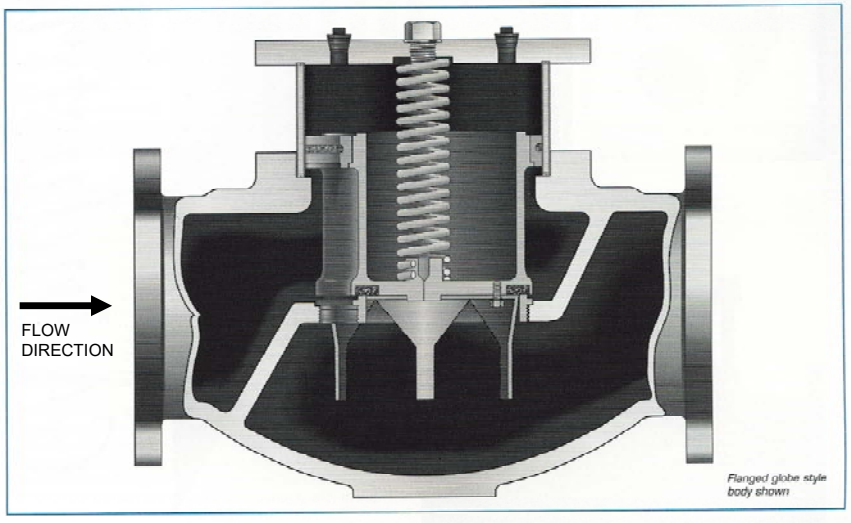


Pressure Reducing Valve Operation

SERIES 2000 pressure reducing valves will throttle to maintain a steady downstream pressure as set by the pilot spring adjustment. The valve will close drip-tight when the downstream pressure exceeds the pilot setting.

VALVE CLOSED

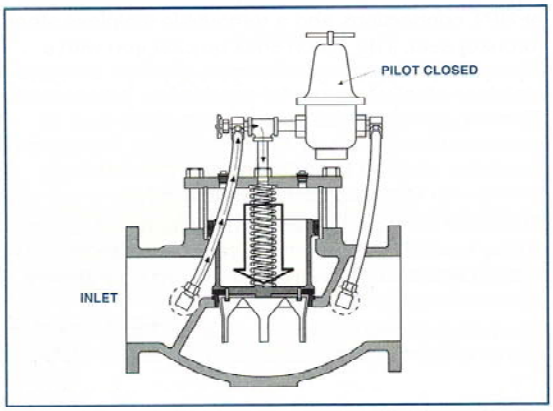


Figure 1. Valve closed when downstream pressure exceeds pilot setting

The valve is installed with flow "over the seat." Inlet pressure is conveyed to the top of the piston by means of a small pilot line and a closing speed control needle valve. Downstream pressure is applied to the underside of the pilot valve's diaphragm and is opposed by the pilot's adjusting spring. The pilot closes when the downstream pressure exceeds the adjusting spring set point, allowing inlet pressure to build on the upper surface of the piston and hold the main valve closed.

VALVE OPEN

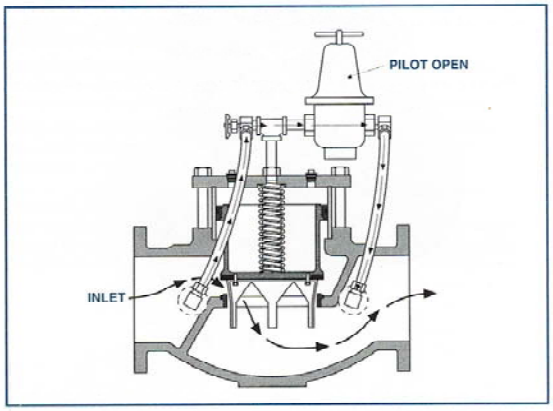
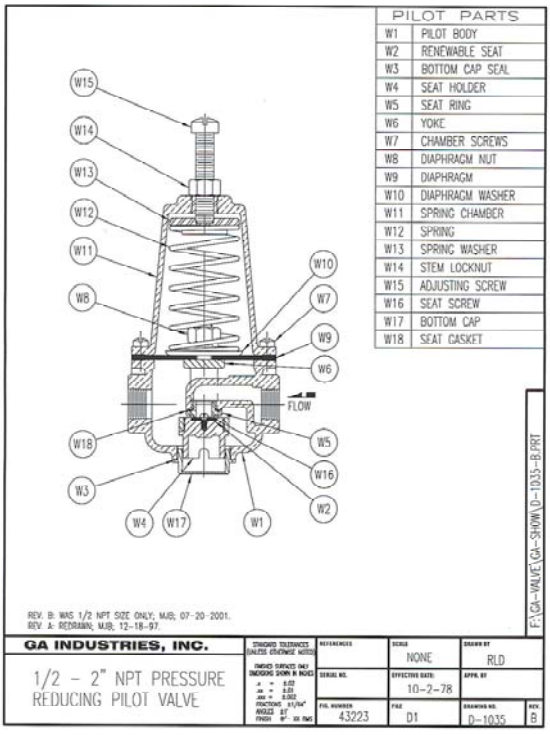


Figure 2. Valve throttles to satisfy demand at setting of pilot

Should downstream pressure fall to the setting of the pilot spring, the pilot opens and allows flow from above the piston to the downstream side of the valve at a faster rate than can be applied through the inlet needle valve. This reduces the pressure on the upper surface of the piston so that inlet pressure, which is constantly applied to the underside of the piston, lifts the piston and opens the main valve. The pilot "throttles" the main valve, allowing sufficient flow to match demand in order to maintain the downstream pressure as determined by the pilot setting.



Related In Plant Valves

Plant Pump Check Valves

COMMONLY USED PUMP CHECK VALVES

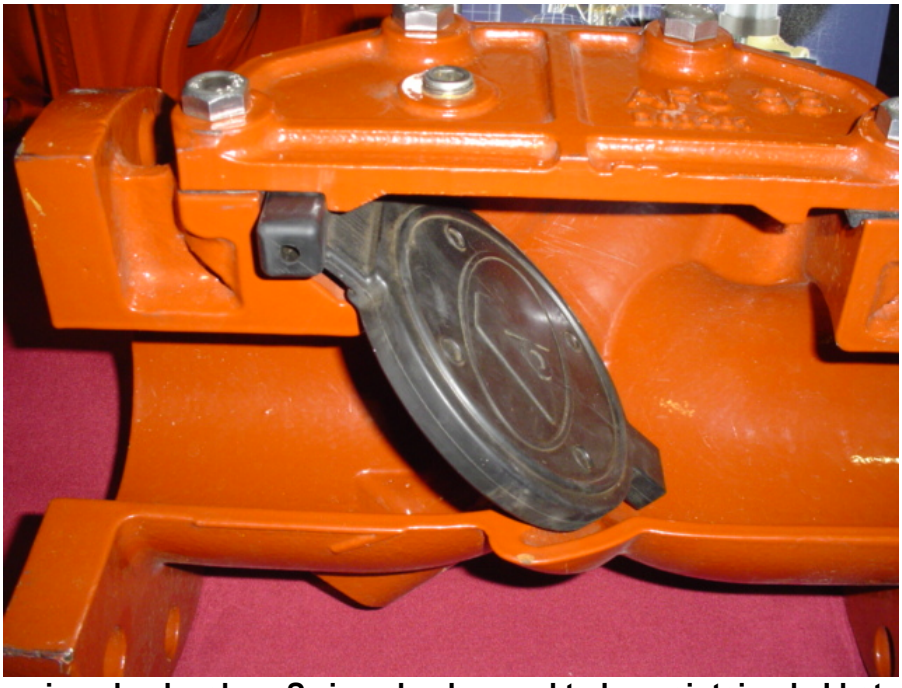
Plain Swing
check valve

Lever and Spring
Swing check valve

Lever and Weight
Swing check valve

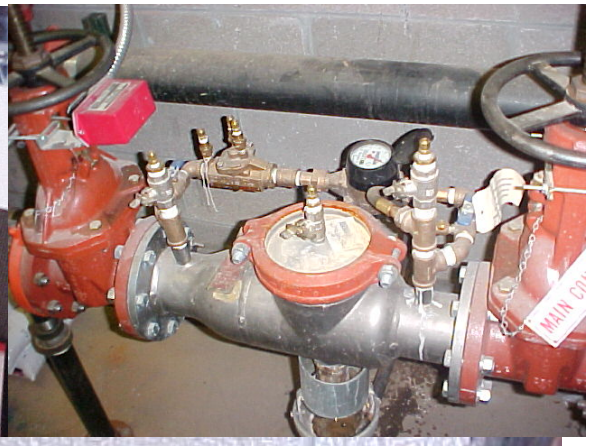
Rubber Flapper
Swing check valve

Surge Relief valves are not usually employed due to short pipe runs in the plant.

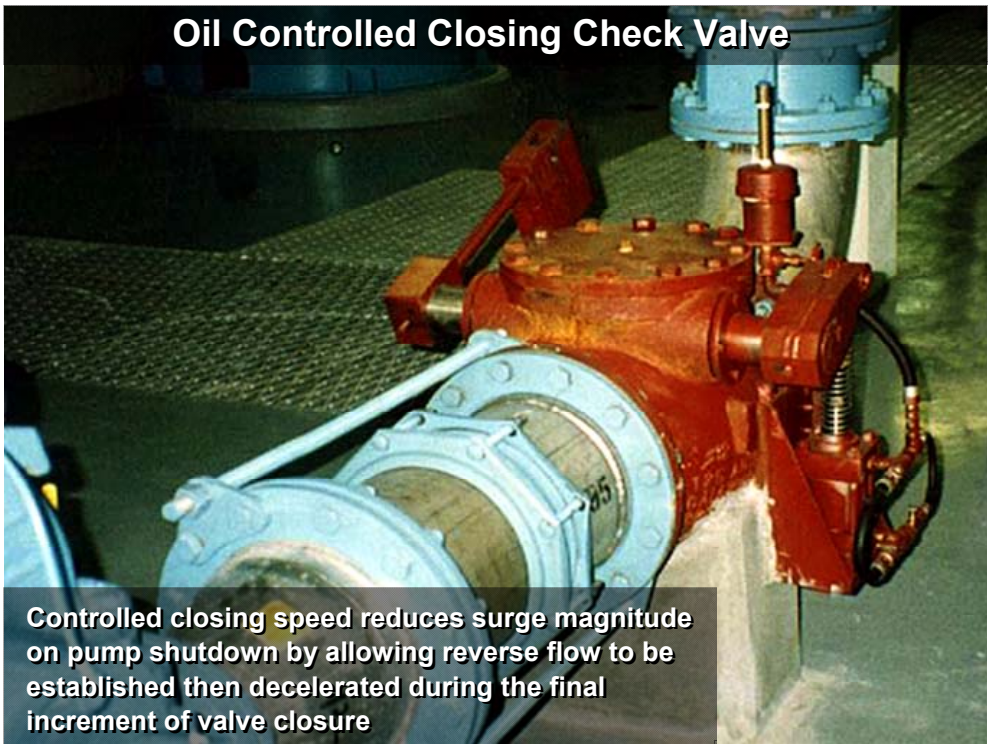


A beautiful swing check valve. Swing checks need to be maintained. I hate finding a swing check that is either buried and/or forgotten, rusted in place or, my favorite, the check was removed. Yes, folks, you too will find these three conditions. Send me a picture if you do. I love stories and pictures from the field.

Check Valves are not backflow preventors. The big difference is a legal term that means two independent mechanical acting check valves with two shut offs which is checked annually by a certified general tester. We will explore the differences later. If I had to use a check valve, I would choose plastic and would check it every six months because I don't trust them. Why? Because everything that is mechanical is subject to failure. Lots of nasties in the water too. The bottom left picture--a cut-away of a handsome spring loaded check valve. Right picture--this looks like a check valve but really is a RP backflow preventor. Notice the smaller one in the background. Very bottom--A fireline check valve. This is probably the most political valve I can think of. Yes, I said political. Fire regulations are a whole new empire to work in.



Wastewater Section

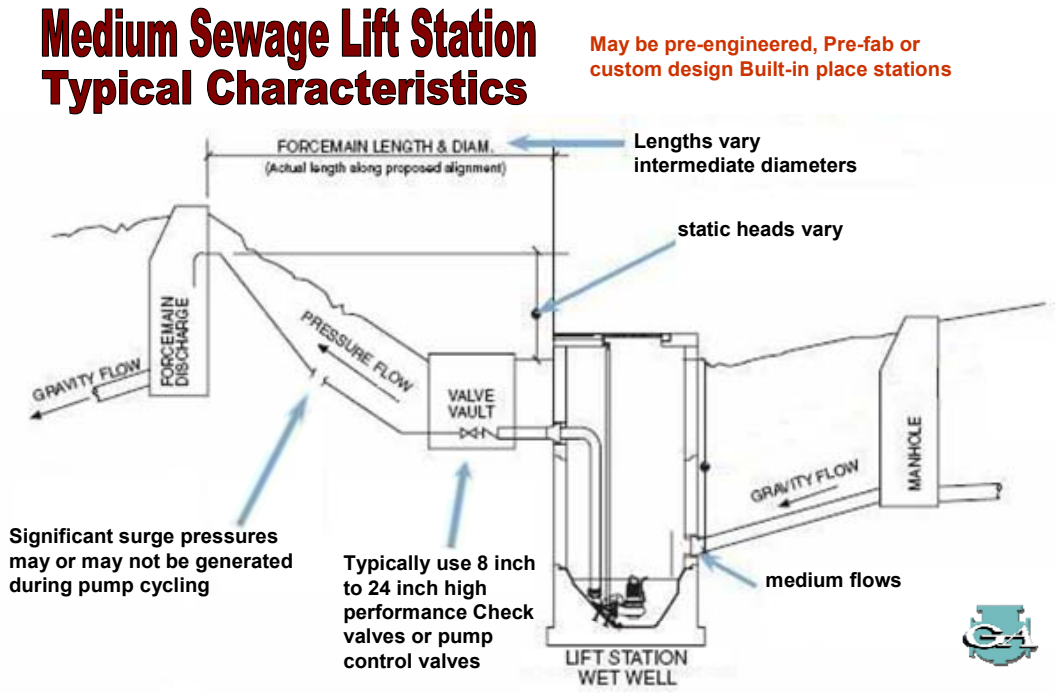


Wastewater valves are widely used in different industries like dairy, food, pharmaceutical, medical and chemical industries to name a few.

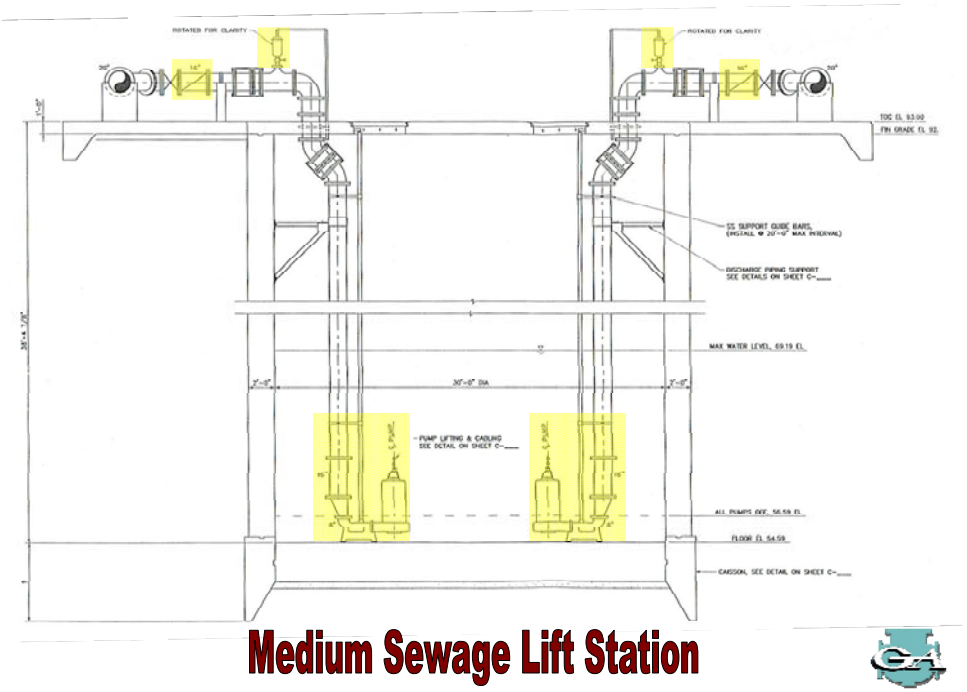
These sanitary valves perform various features like easy cleaning, crevice free, and polish contact surfaces. Types among these sanitary valves can be seen in the form of sanitary ball valves, sanitary sewer valves, sanitary butterfly valves, sanitary check valves, sanitary globe valves and many other such sanitary valves.

Variations among these sanitary valves can also be seen in their working pressure and operating temperature. These sanitary valves carry gas and liquid media or liquid with suspended solids. Metals like brass, bronze, copper, cast iron, ductile iron, stainless steel, and steel are used in the manufacture of these sanitary valves to ensure that they have a longer life.

Lift Station



(Hint: If your pump station is too big to unload with a fork lift, but smaller than the biggest building in town, its probably a medium size lift station.)



Sludge pumping from Settling Basins using Progressive Cavity Pumps

Pump runs but little or no fluid comes out.

1. Check that the discharge isolation valve is not closed.
2. Ensure that supply pressure is high enough to overcome application head pressure requirements.
3. Check for pump cavitation; slow pump speed down to match the thickness of the material being pumped.
4. **Check to make sure that all suction connections are air tight, and that the clamp bands are properly tightened.**

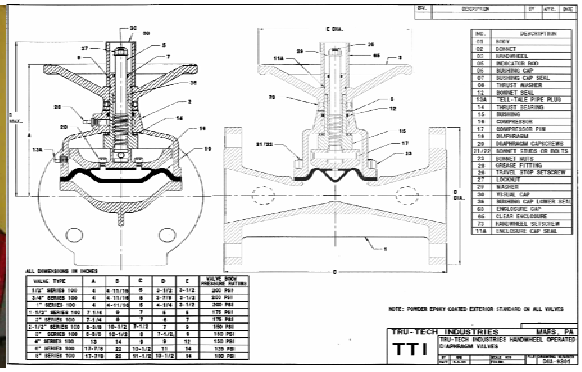
Slurry or Sludge Pump Isolation Valves

Possible Valve Choices:

Plug Valve
1. Good for abrasion
(Metal seated & Resilient).
2. Not so good on suction side
(Leaky stem seals allow air in,
Chevron packings are made to seal
against positive pressure and not vacuum).
3. Build-up in bearing journals increase
the valve torque making them difficult to open.

Pinch Valve
1. Good for abrasion
(Rubber sleeved)
2. Not so good on suction side
(Sleeve can be sucked closed)

Slurry or Sludge Pump Isolation valves



Best choice:
Diaphragm Isolation Valve
1. No packing to leak resilient rubber diaphragm seals the bonnet area
2. No areas for build-up to occur increasing torque
3. Reinforced diaphragm won't suck closed

Tru-Tech Industries
A GA Company

Chemical Feed Isolation and Modulating Control

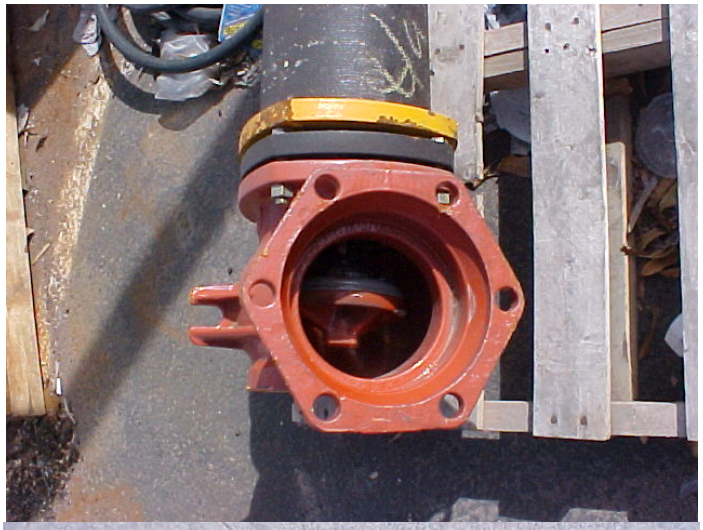
- Natural Rubber
- Neoprene
- Butyl
- EPDM
- Hypalon
- Viton
- Teflon

Valve Exercising Section

Valve exercising should be done once per year (especially main line valves) to detect malfunctioning valves and to prevent valves from becoming inoperable due to freezing or build-up of rust or corrosion. A valve inspection should include drawing valve location maps to show distances (ties) to the valves from specific reference points (telephone poles, stonelines, etc.).

Hydrants are designed to allow water from the distribution system to be used for fire-fighting purposes.

Bottom of a dry barrel fire hydrant--there is a drainage hole on the back of this hydrant, sometimes referred to as a "weep hole". Below is an "Airport Runway" type of hydrant. These are difficult to find.



Here are Common Valve Operation Problems

Valve stem is improperly lubricated or damaged--I always liked to find a bent brass stem. Just a small bend will make most valves difficult to operate. This also applies to misplaced valve boxes. It is best to disassemble the valve and inspect the stem. Acceptable deviation from theoretical centerline created by joining center points of the ends of the stem is 0.005"/ft of stem. Inspect the threads for any visible signs of damage. Small grooves less than 0.005" can be polished with an Emory cloth. Contact specialized services or an outside contractor if run-out is unacceptable or large grooves are discovered on the surface of the stem.

Valve packing compression is too tight--Verify the packing bolt torque and adjust if necessary.

Foreign debris is trapped on threads and/or in the packing area--This is a common problem when valves are installed outdoors in sandy areas and in areas not cleaned before operating. Always inspect threads and packing area for particle obstructions; even seemingly small amounts of sand trapped on the drive can completely stop large valves from cycling. The valve may stop abruptly when a cycle is attempted. With the line pressure removed from the valve, disconnect the actuator, gear operator or handwheel and inspect the drive nut, stem, bearings and yoke bushing.

Contaminated parts should be cleaned with a lint-free cloth using alcohol, varsol or the equivalent. All parts should be re-lubricated before re-assembly. If the valves are installed outdoors in a sandy area, it may be desirable to cover the valves with jackets.

Valve components are faulty or damaged-- contact the supply house or warehouse. Most valve salesmen will try to keep your business and do what ever is possible to do so. In the last ten years only one manufacturer did not replace a faulty valve. It is one of the largest makers of water valves and blew me off. It was clearly a bad valve to begin with. Sad part of this story is that the large American valve companies have to deal with aggressive Chinese valve companies that will make things right to keep your business. Most of these valves that I have seen are great for most water and wastewater work. They have nice finishes and even come in stainless steel--Probably made from recycled American cars. I just hate to switch over to any thing other than American but I guess we are living in a Global market.

The handwheel is too small--Increasing the size of the handwheel will reduce the amount of torque required to operate the valve. If a larger handwheel is installed, the person operating the valve must be careful not to over-torque the valve when closing it. Most Valve operators will have a set of special keys for the operation of most valves but a small wheel can present problems as well as no hand wheel. Dr. Durbin's commentary, Over the years and at most systems, it seems that the institutional knowledge that most of the old timers have is priceless and under appreciated by most management. The reason I say this is most experienced Valvemen or Valve Operators know their system better than any map or GIS system. Don't throw these people under the bus!

Slam, Surge and Water Hammer

When a valve is closed *instantaneously* there is a corresponding *instantaneous* pressure rise, causing a water hammer.

Water hammer (or, more generally, fluid hammer) is a pressure surge or wave caused by the kinetic energy of a fluid in motion when it is forced to stop or change direction suddenly. It depends on the fluid compressibility where there are sudden changes in pressure. For example, if a valve is closed suddenly at the end of a pipeline system, a water hammer wave propagates in the pipe. Moving water in a pipe has kinetic energy proportional to the mass of the water in a given volume times the square of the velocity of the water.

The Effects of Water Hammer And Pulsations
Quick closing valves, positive displacement pumps, and vertical pipe runs can create damaging pressure spikes, leading to blown diaphragms, seals and gaskets, and also destroyed meters and gauges.

Liquid, for all practical purposes, is not compressible: any energy that is applied to it is instantly transmitted. This energy becomes dynamic in nature when a force such as a quick closing valve or a pump applies velocity to the fluid.

Surge (Water Hammer)
Surge (or water hammer, as it is commonly known) is the result of a sudden change in liquid velocity. Water hammer usually occurs when a transfer system is quickly started, stopped or is forced to make a rapid change in direction. Any of these events can lead to catastrophic system component failure. Without question, the primary cause of water hammer in process applications is the quick closing valve, whether manual or automatic. A valve closing in 1.5 sec. or less depending upon valve size and system conditions causes an abrupt stoppage of flow. The pressure spike (acoustic wave) created at rapid valve closure can be high as five(5) times the system working pressure.

For this reason, most pipe-sizing charts recommend keeping the flow velocity at or below 5 ft/s (1.5 m/s). If the pipe is suddenly closed at the outlet (downstream), the mass of water before the closure is still moving forward with some velocity, building up a high pressure and shock waves. In domestic plumbing this is experienced as a loud bang resembling a hammering noise. Water hammer can cause pipelines to break or even explode if the pressure is high enough. Air traps or stand pipes (open at the top) are sometimes added as dampers to water systems to provide a cushion to absorb the force of moving water in order to prevent damage to the system. (At some hydroelectric generating stations, what appears to be a water tower is actually one of these devices.) The water hammer principle can be used to create a simple water pump called a hydraulic ram.

On the other hand, when a valve in a pipe is closed, the water downstream of the valve will attempt to continue flowing, creating a vacuum that may cause the pipe to collapse or implode. This problem can be particularly acute if the pipe is on a downhill slope. To prevent this, air and vacuum relief valves, or air vents, are installed just downstream of the valve to allow air to enter the line and prevent this vacuum from occurring.

Unrestricted, this pressure spike or wave will rapidly accelerate to the speed of sound in liquid, which can exceed 4000 ft/sec. It is possible to estimate the pressure increase by the following formula.

Water Hammer Formula: P = (0.070) (V) (L) / t + P1

Where P = Increase in pressure
P1 = Inlet Pressure
V = Flow velocity in ft/sec
t = Time in sec.(Valve closing time)
L = Upstream Pipe Length in feet

Here's an example of pressure hammer when closing an EASMT solenoid valve, with a 50 ft long upstream pipe connection:

L = 50 ft
V = 5.0 ft / sec(recommended velocity for PVC piping design)
t = 40 ms(solenoid valve closing time is approx. 40-50 ms)
P1 = 50 psi inlet pressure

therefore, P = 0.07 x 5 x 50 / 0.040 + P1
or P = 437.5 psi + P1

Total Pressure = 437.5 + 50 = 487.5 psi

Pulsation

Pulsation generally occurs when a liquid's motive force is generated by reciprocating or peristaltic positive displacement pumps. It is most commonly caused by the acceleration and deceleration of the pumped fluid. This uncontrolled energy appears as pressure spikes. Vibration is the visible example of pulsation and is the culprit that usually leads the way to component failure.

Unlike centrifugal pumps(which produce normally non-damaging high-frequency but low-amplitude pulses), the amplitude is the problem because it's the pressure spike. The peak, instantaneous pressure required to accelerate the liquid in the pipe line can be greater than ten (10) times the steady state flow pressure produced by a centrifugal pump. Damage to seals gauges, diaphragms, valves and joints in piping result from the pressure spikes created by the pulsating flow.

Remedy

Suggest that you install a pulsation dampener or surge tank. Dampeners provide the most cost efficient and effective choice to prevent the damaging effects of pulsation. A surge suppressor is in design essentially the same as pulsation dampener. The difference primarily lies in sizing and pressurizing. The most current pulsation dampener design is the hydro-pneumatic dampener, consisting of a pressure vessel containing a compressed gas, generally air or Nitrogen separated from the process liquid by a bladder or diaphragm.

References

Several Photographs and Reference were provided by
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