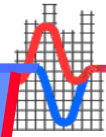


Existing Building Commissioning (EBCx)

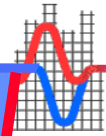


Workshop Series Year 18
Session 13

Lab:

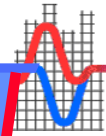
**Hydronic Valve
Types & Properties**

Lab Overview



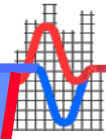
- Valve functions
- Types of valves commonly used in buildings
- Key valve components
- Valve selection
- Summary

Valve Functions



What roles do valves play in hydronic systems?





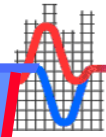
Valve Functions

What roles do valves play in hydronic systems?

- Start or stop flow; i.e., 2-position
- Regulate or throttle flow; i.e., modulating
- Balance flow
- Prevent reverse flow; e.g., check valve
- Change flow direction; e.g., diverting
- Limit system pressure; e.g., PRV
- Limit system flow

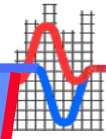
In hydronic systems, a valve is any device that regulates or stops the flow of water.

Valves in Building Mechanical Systems



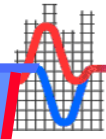
What building systems include hydronic valves?

- Chilled water
- Heating hot water
- Steam and steam condensate
- Domestic hot water
- Domestic cold water
- Industrial water (e.g., DI and RO water)
- Grey water
- Wastewater



Common Valve Types

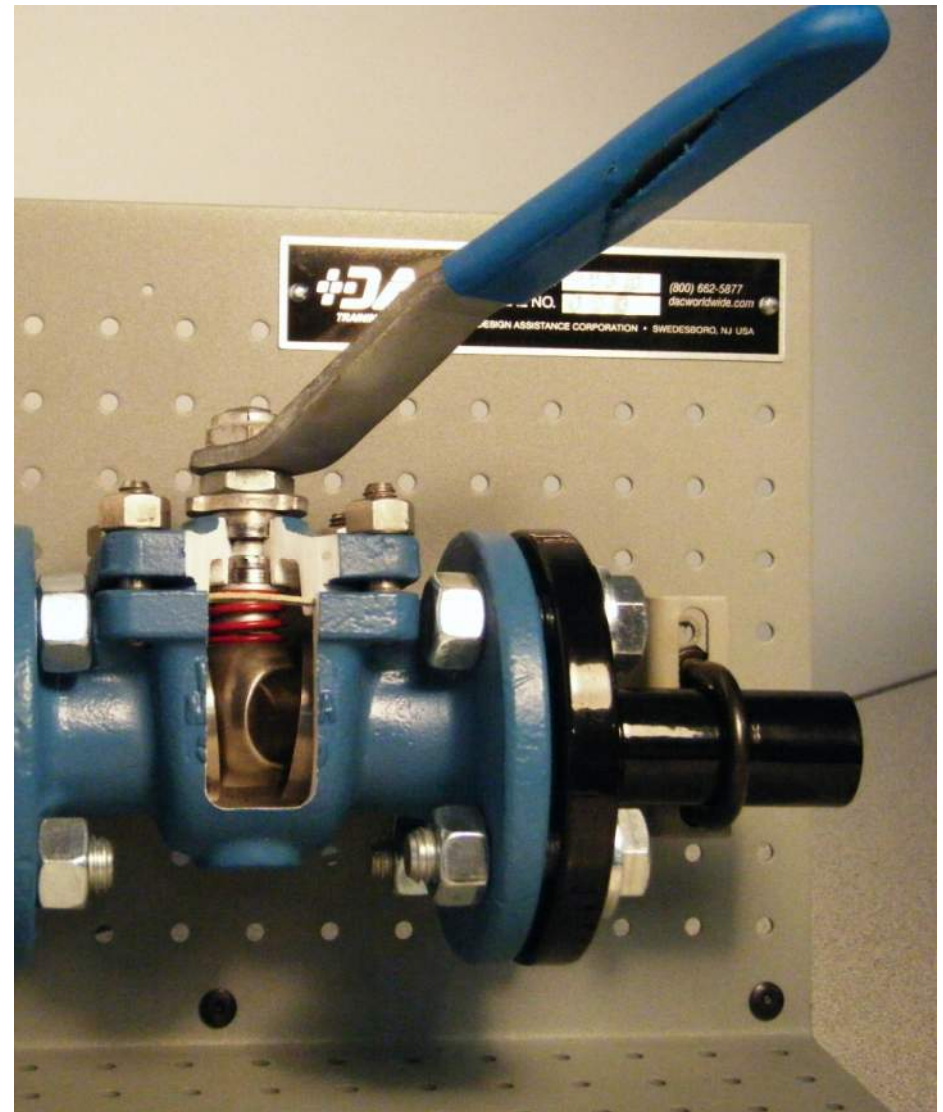
- Ball Valve
- Butterfly Valve
- Gate Valve
- Plug Valve
- Globe Valve
- Check Valve
- Pressure Reducing Valve
- Flow Balancing Valve
- Flow Control Valve
- Other

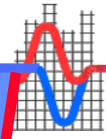


Ball Valve

Ported ball regulates flow through the valve.

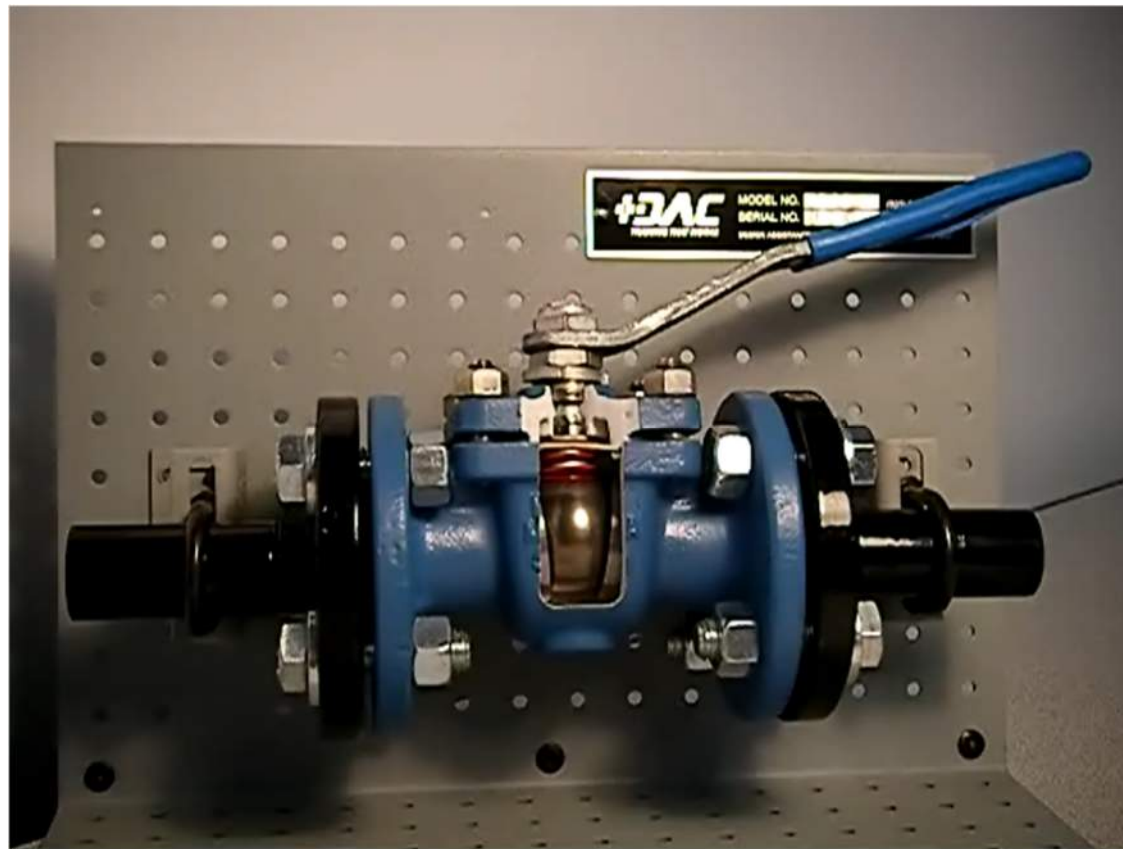
Turning the handle 90° moves the valve from open to closed.

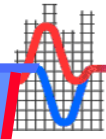




Ball Valve

Animation of valve operation.

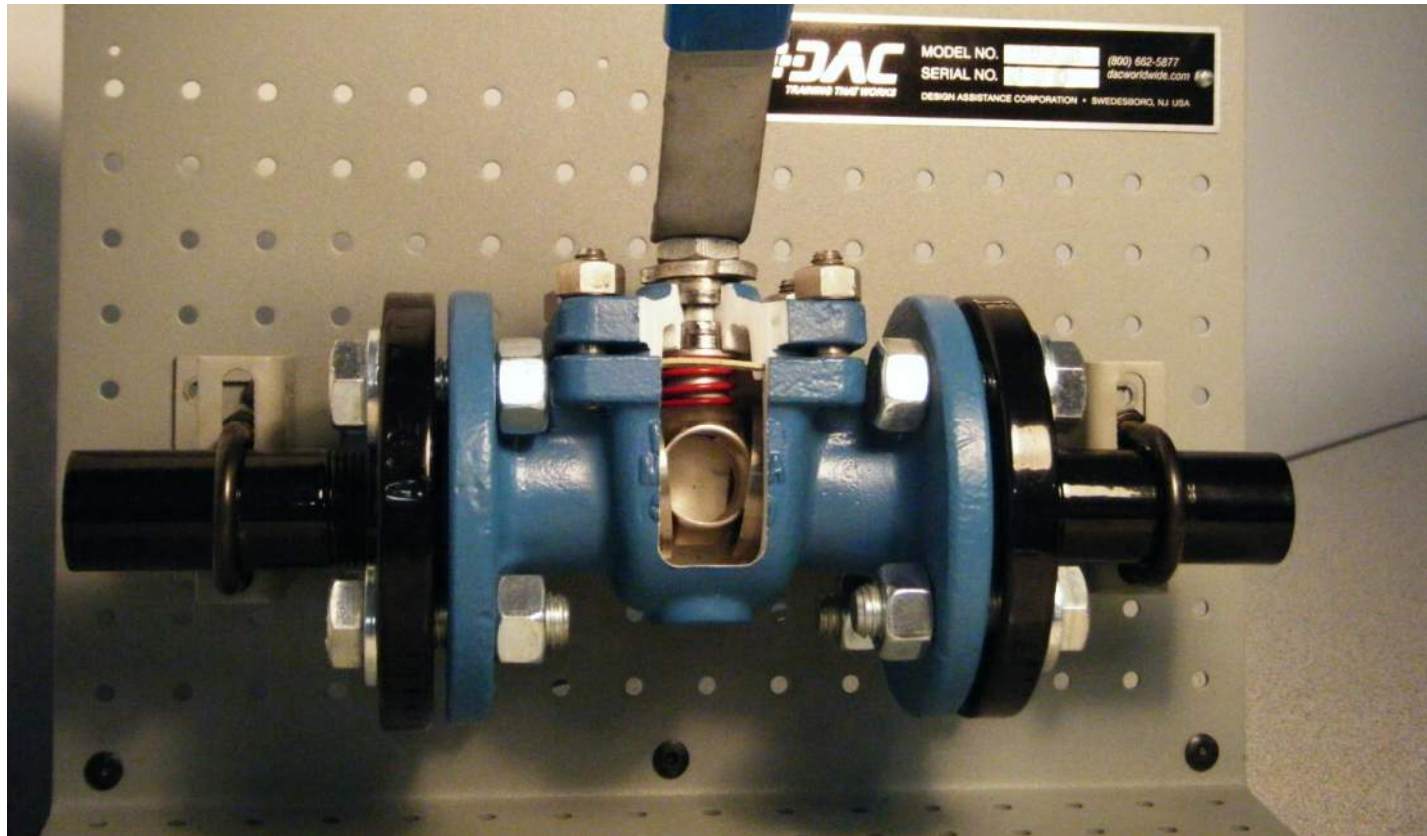


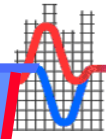


Ball Valve (cont'd)

Common uses?

- Manual isolation in small pipe sizes; e.g., 2" and under
- Modulation with 90° actuators; usually with ported ball



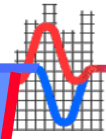


Butterfly Valve

Rotating disk regulates flow through the valve.

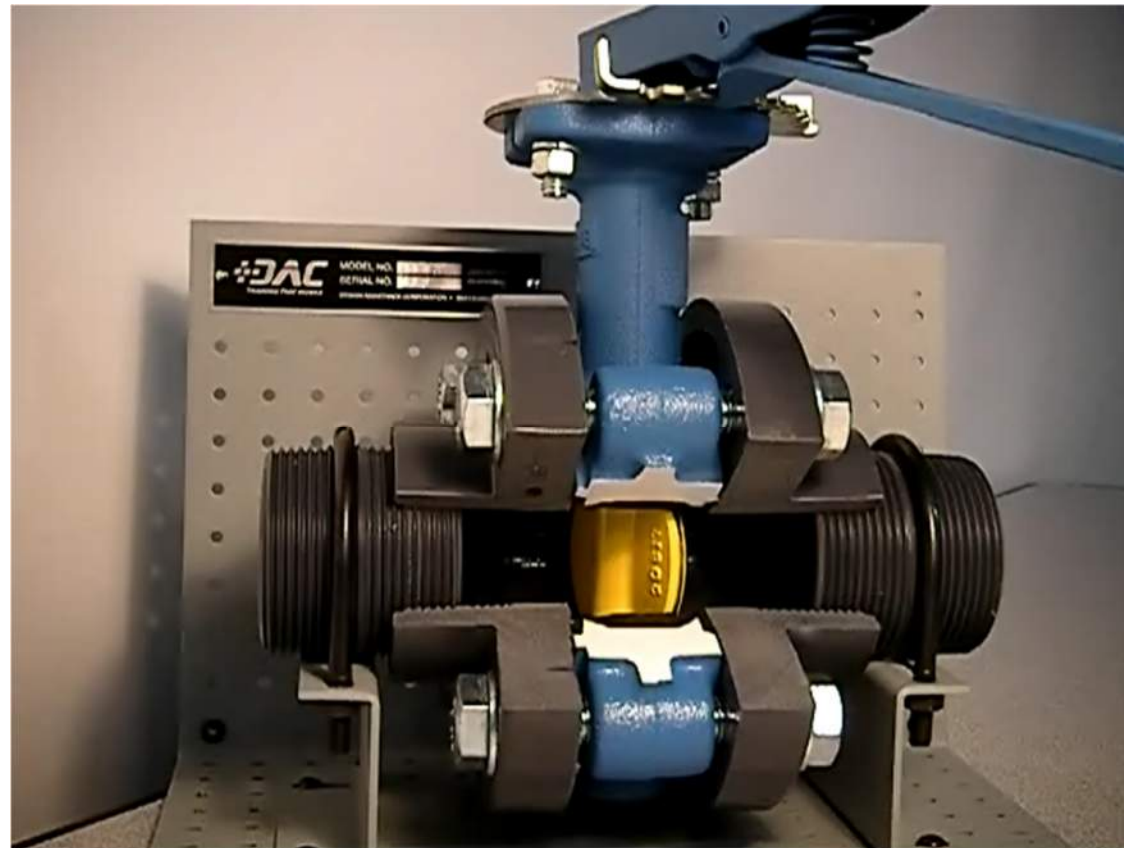
Turning the handle 90° moves the valve from open to closed.

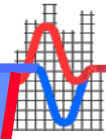




Butterfly Valve

Animation of valve operation.

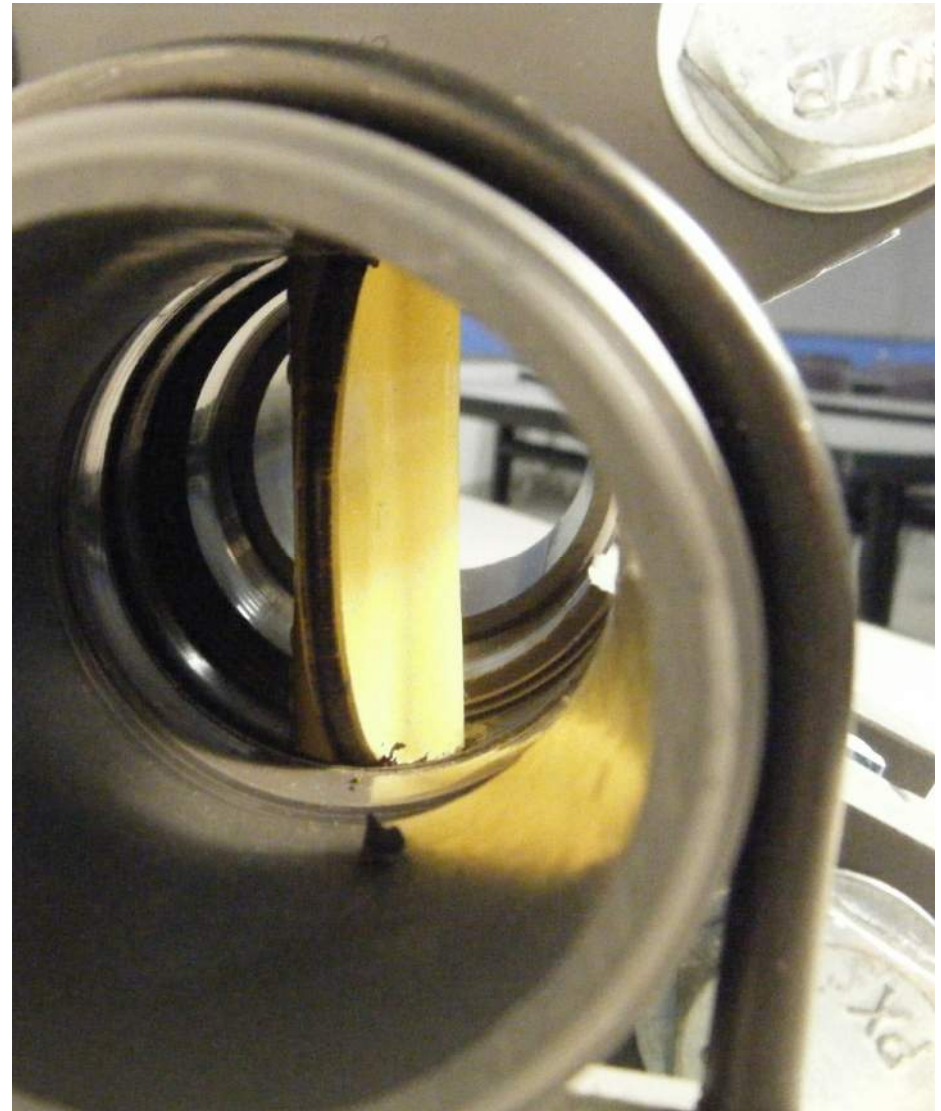


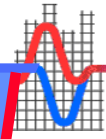


Butterfly Valve (cont'd)

Common uses?

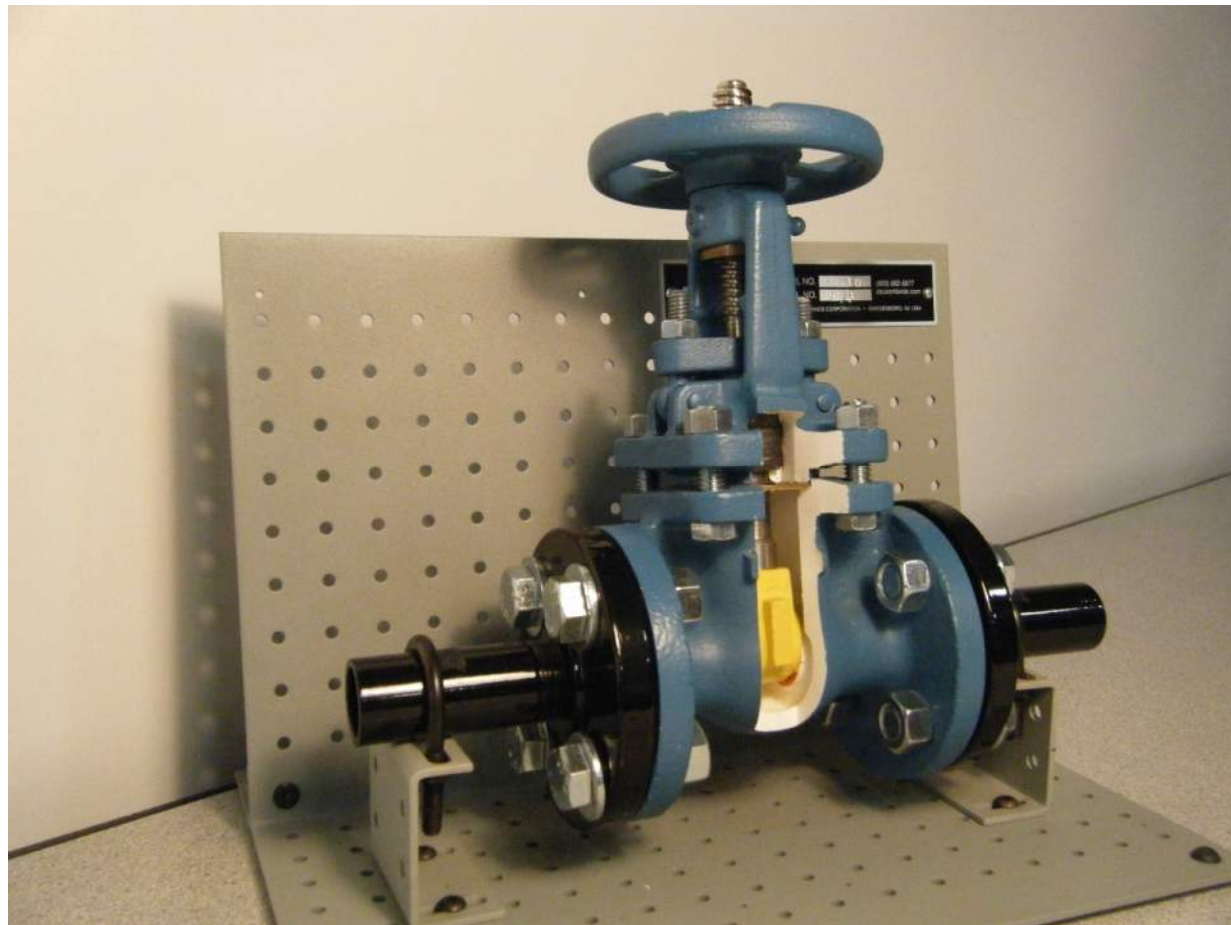
- When a compact installation is needed
- Modulation with 90° actuators

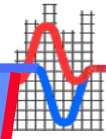




Gate Valve

Wedge or disk moves between machined surfaces perpendicular to the water flow path.

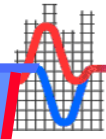




Gate Valve

- Animation of valve operation.

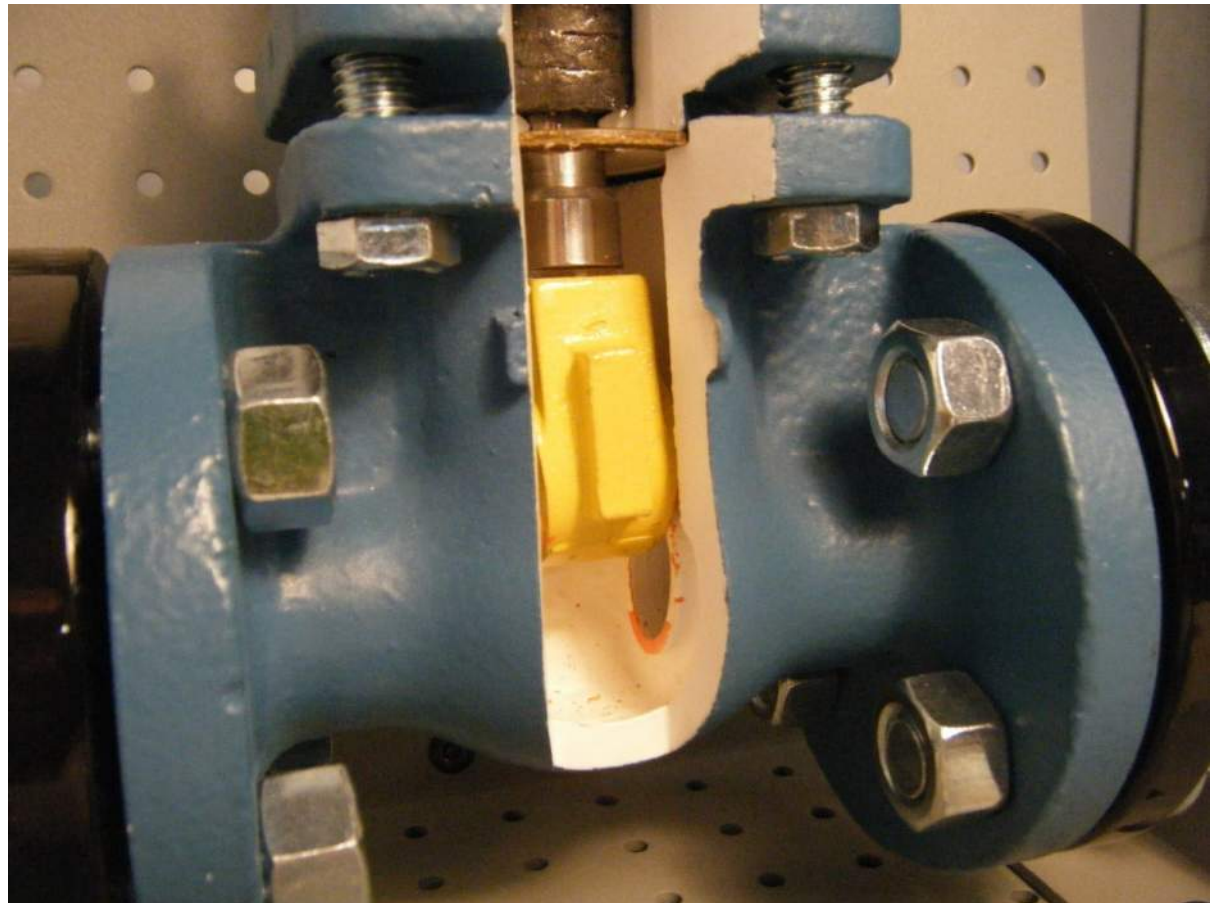




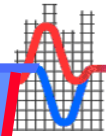
Gate Valve (cont'd)

Common use?

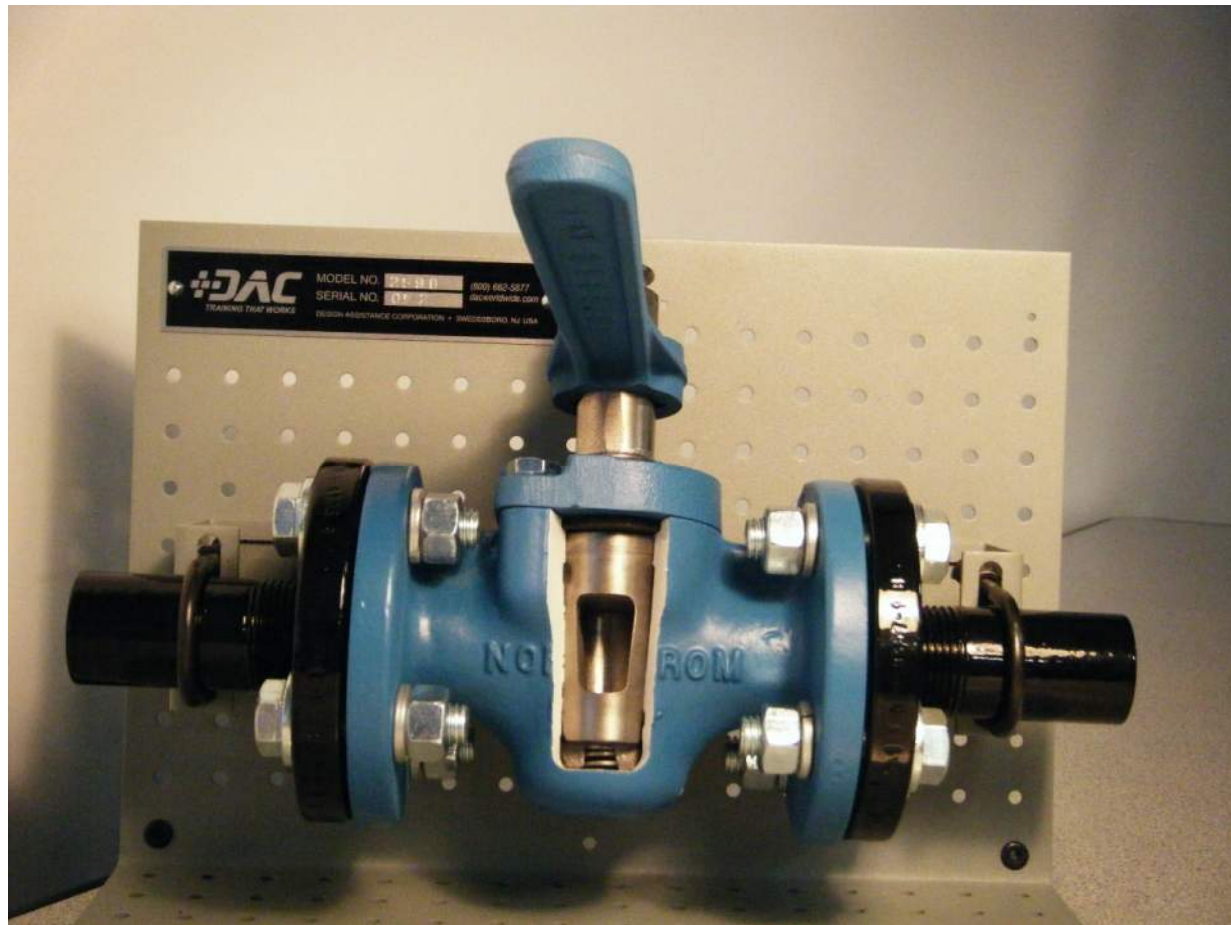
- Shut off flow



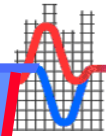
Plug Valve



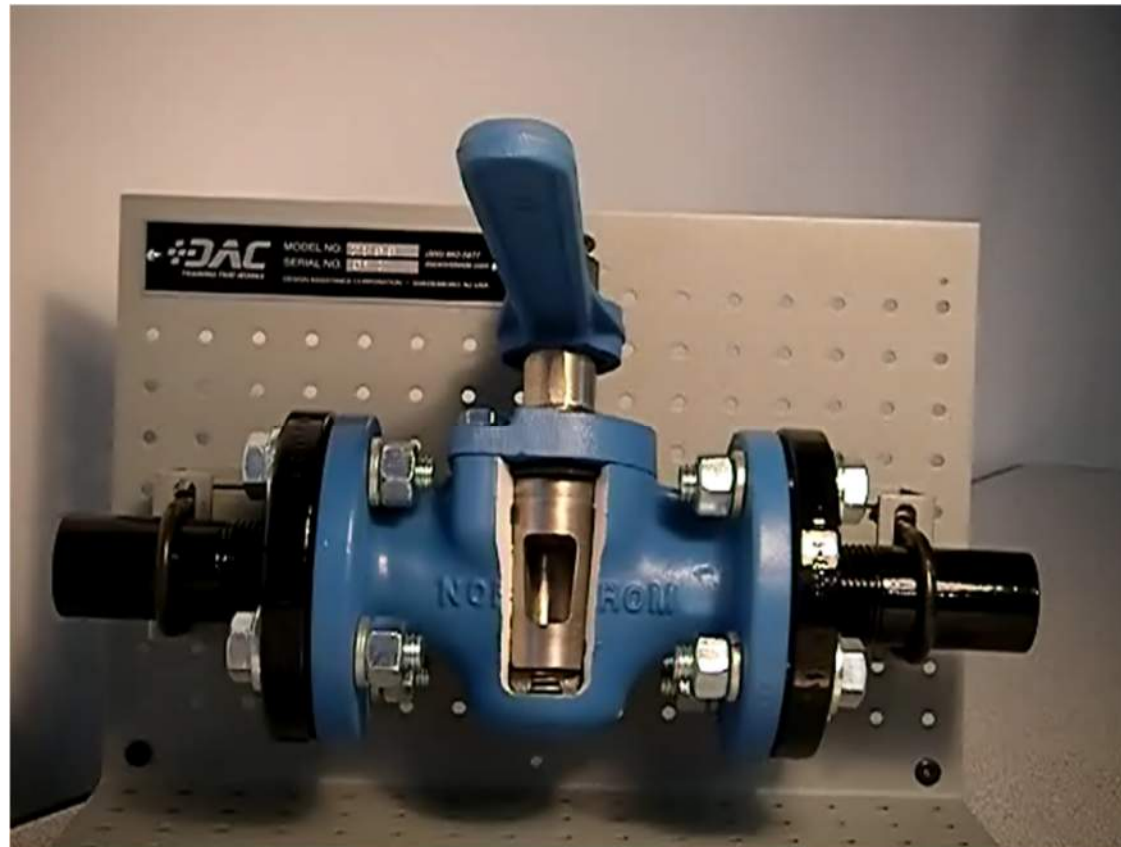
Ported plug turns 90° to control flow.

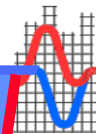


Plug Valve



- Animation of valve operation.

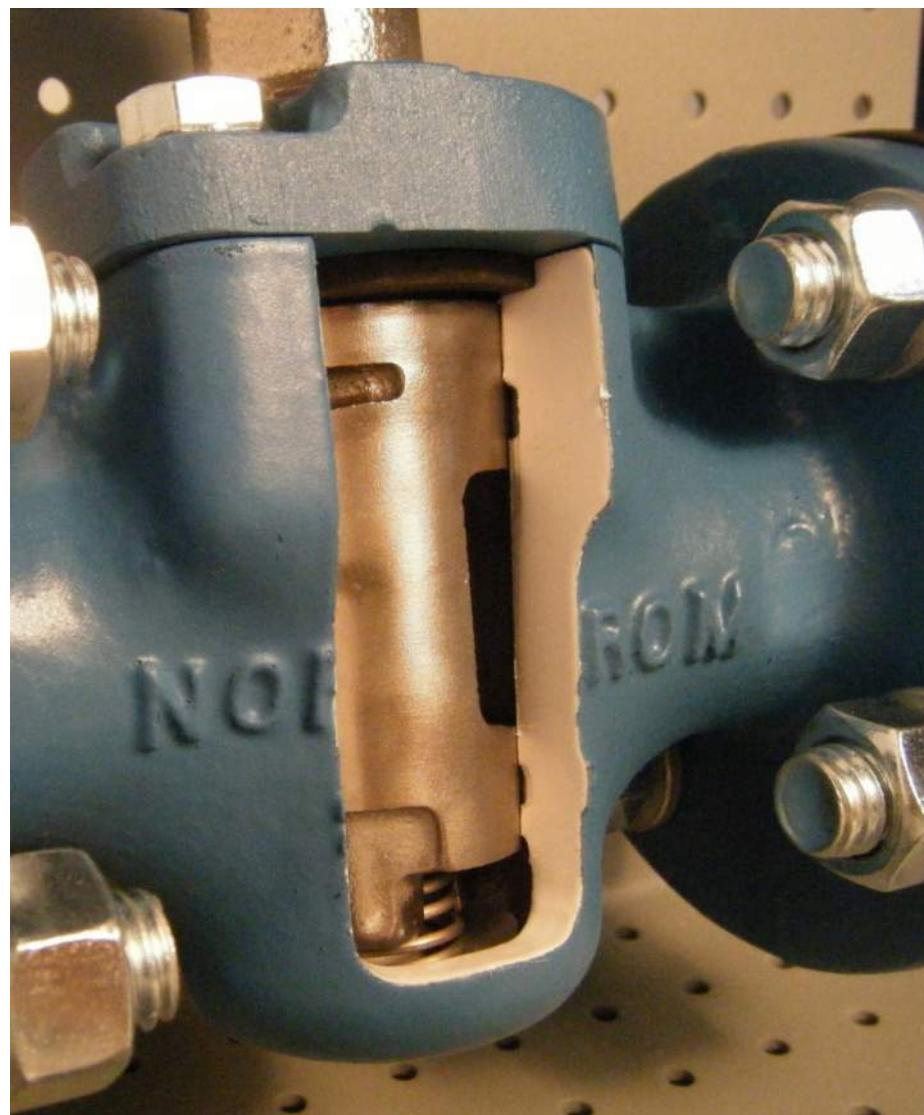


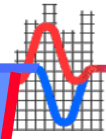


Plug Valve (cont'd)

Common use?

- Shut off flow
- Modulate flow with custom orifice
- Gas shutoff with lubricated plug

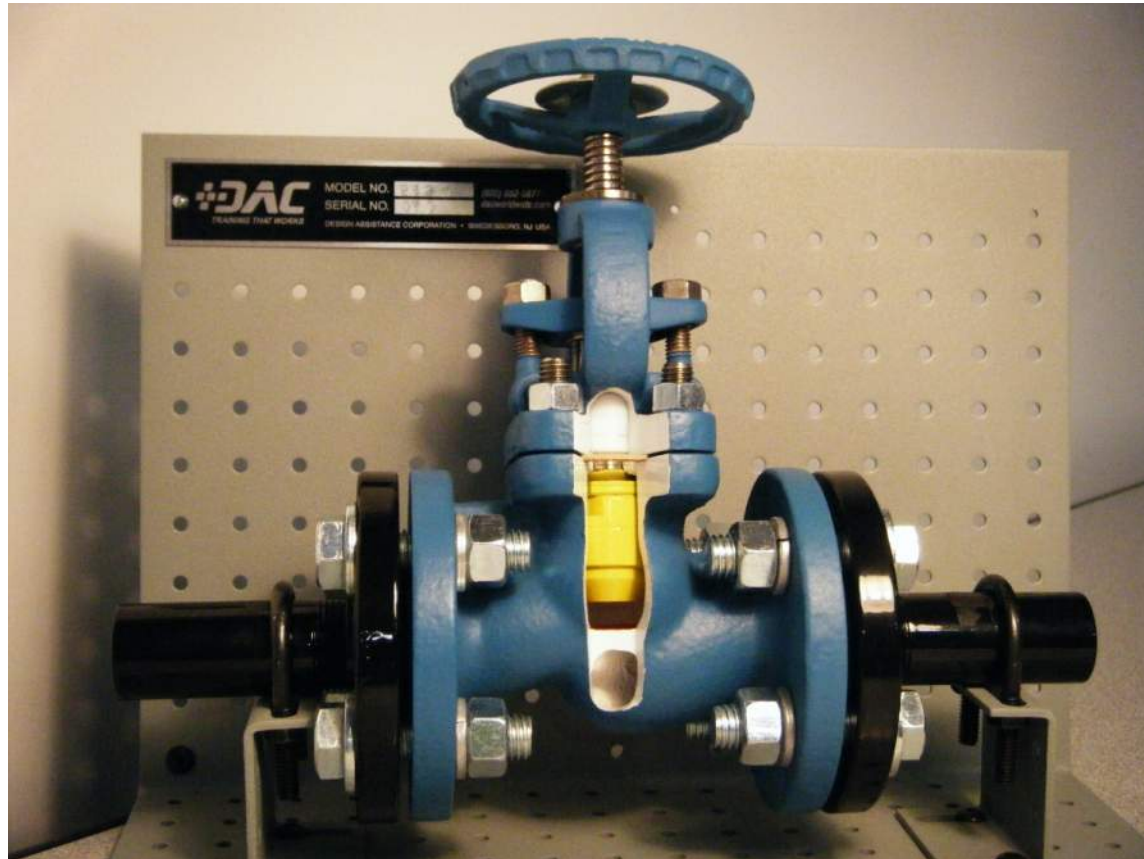


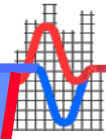


Globe Valve

Circular disk, or globe, moves perpendicular to flow.

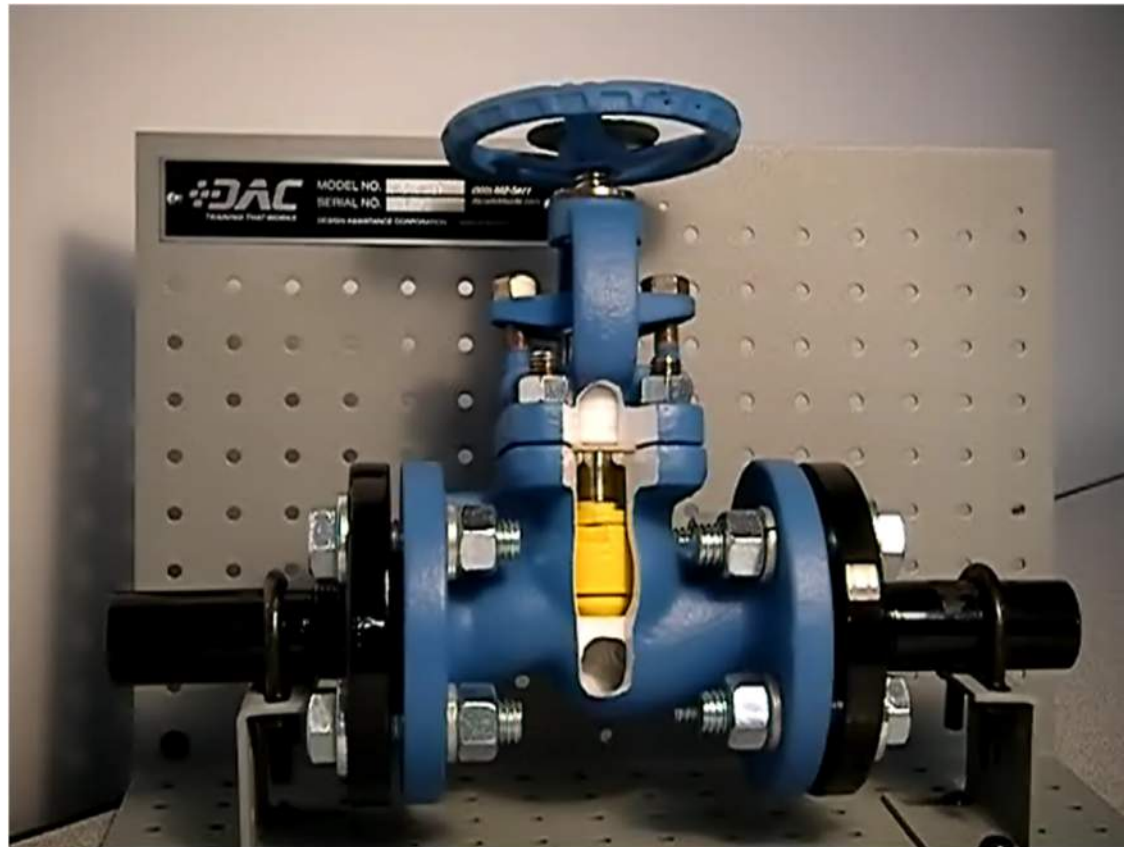
Disk seats in an annular ring.

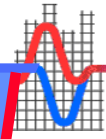




Globe Valve

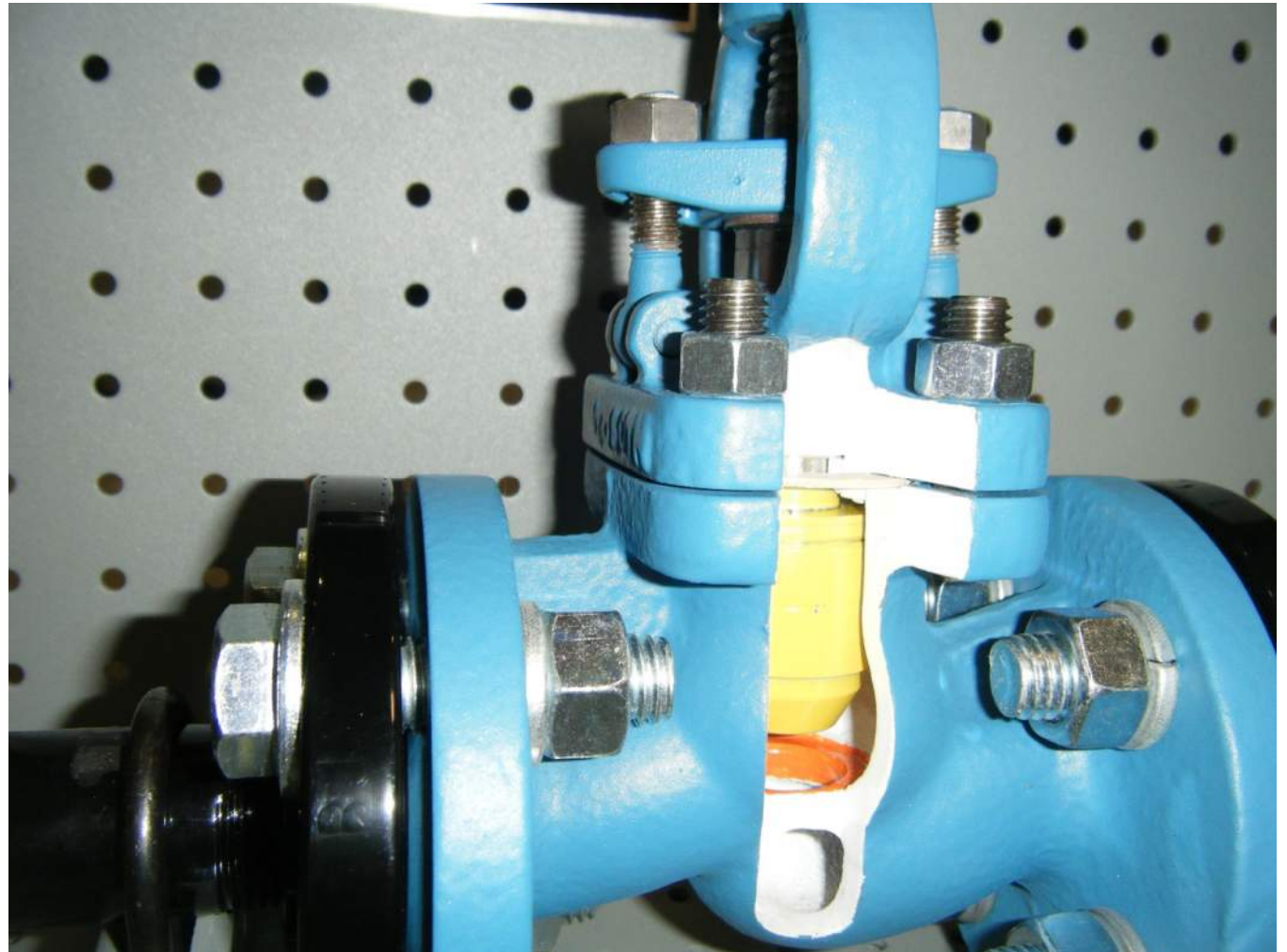
- Animation of valve operation.





Globe Valve (cont'd)

Seating ring

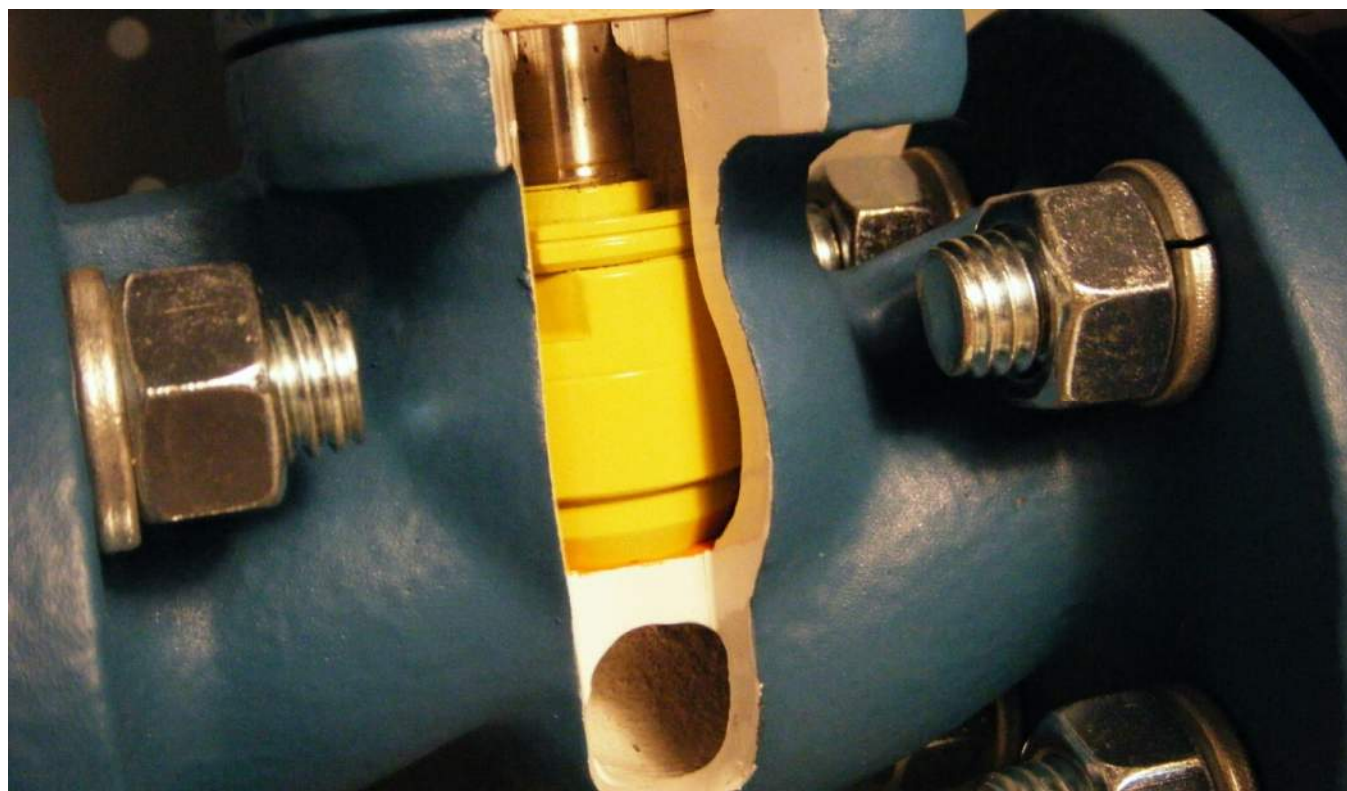


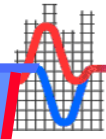


Globe Valve (cont'd)

Common uses?

- Small diameter pipes
- Modulate flow
- Shut off flow

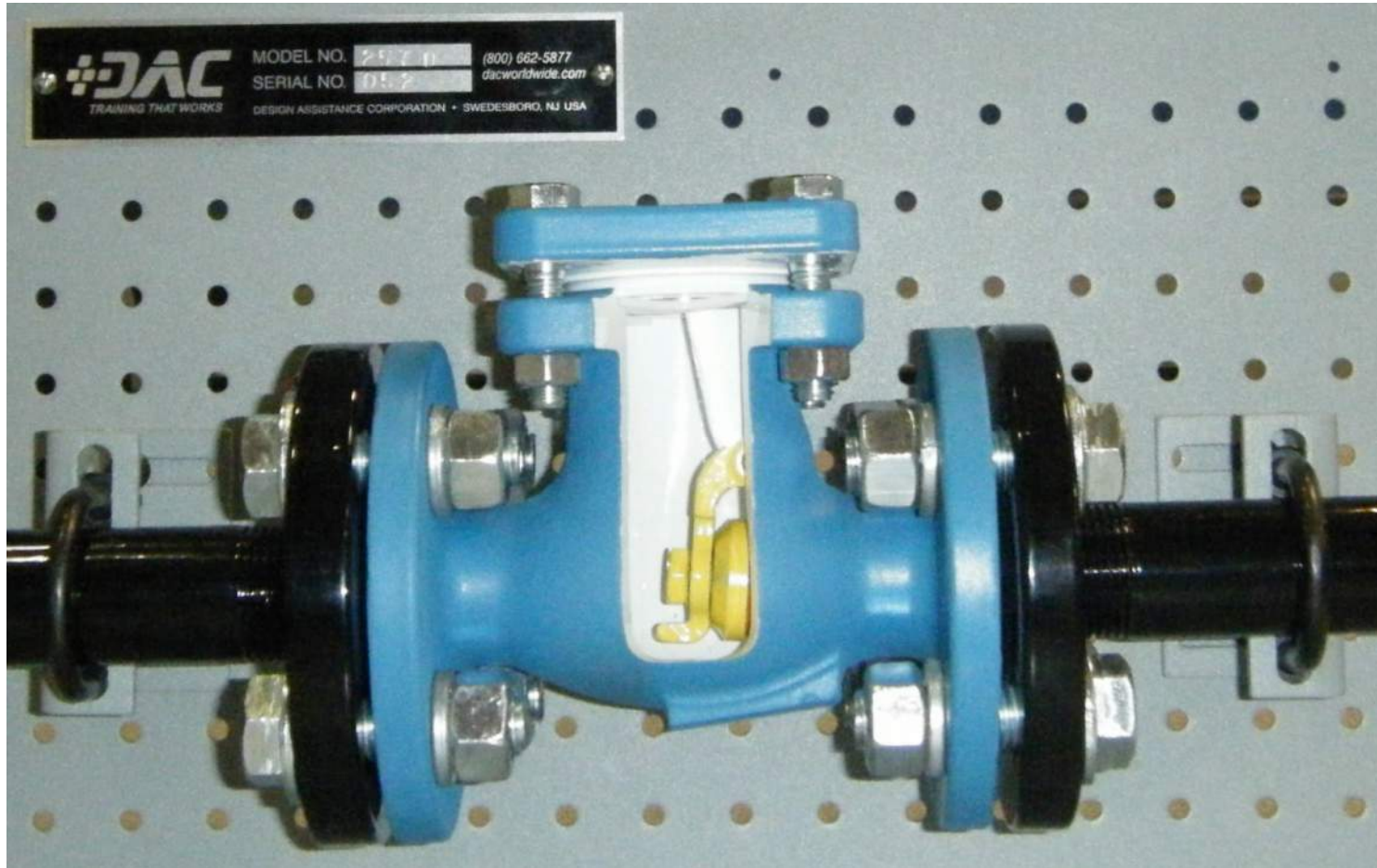


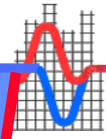


Check Valve

Swing check type uses disk to stop backflow

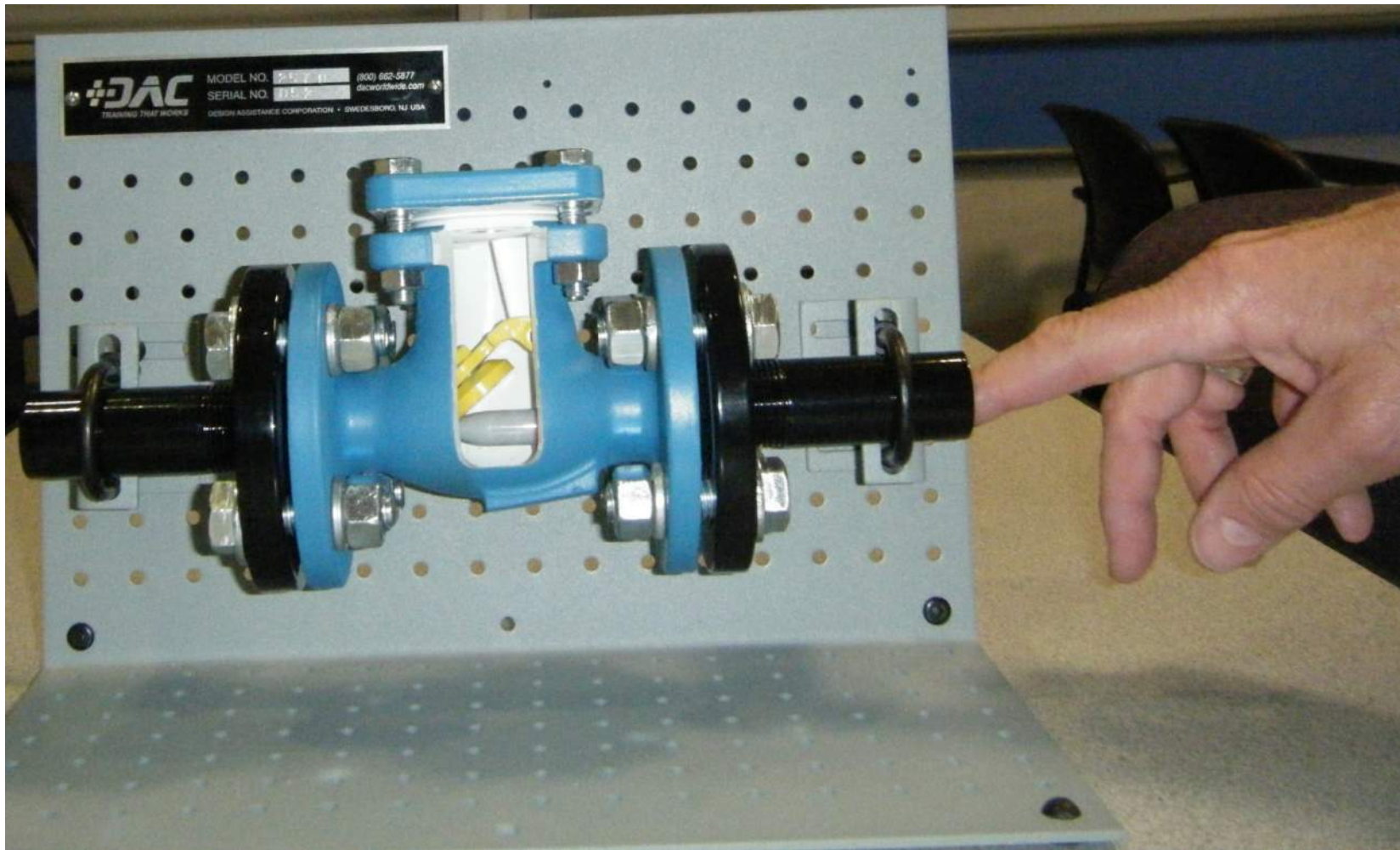
Can also a ball or wafer (similar to butterfly disk)

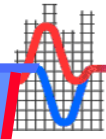




Check Valve (cont'd)

Swing check disk in action



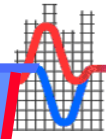


Check Valve (cont'd)

Common uses?

- Discharge line of parallel pumps
- Backflow preventers



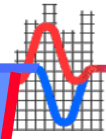


Check Valve (cont'd)

Many uses

- E.g., condenser water pump discharge line

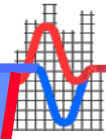




Check Valve (cont'd)

... and a wide range of sizes





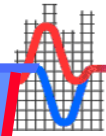
Pressure Reducing Valve



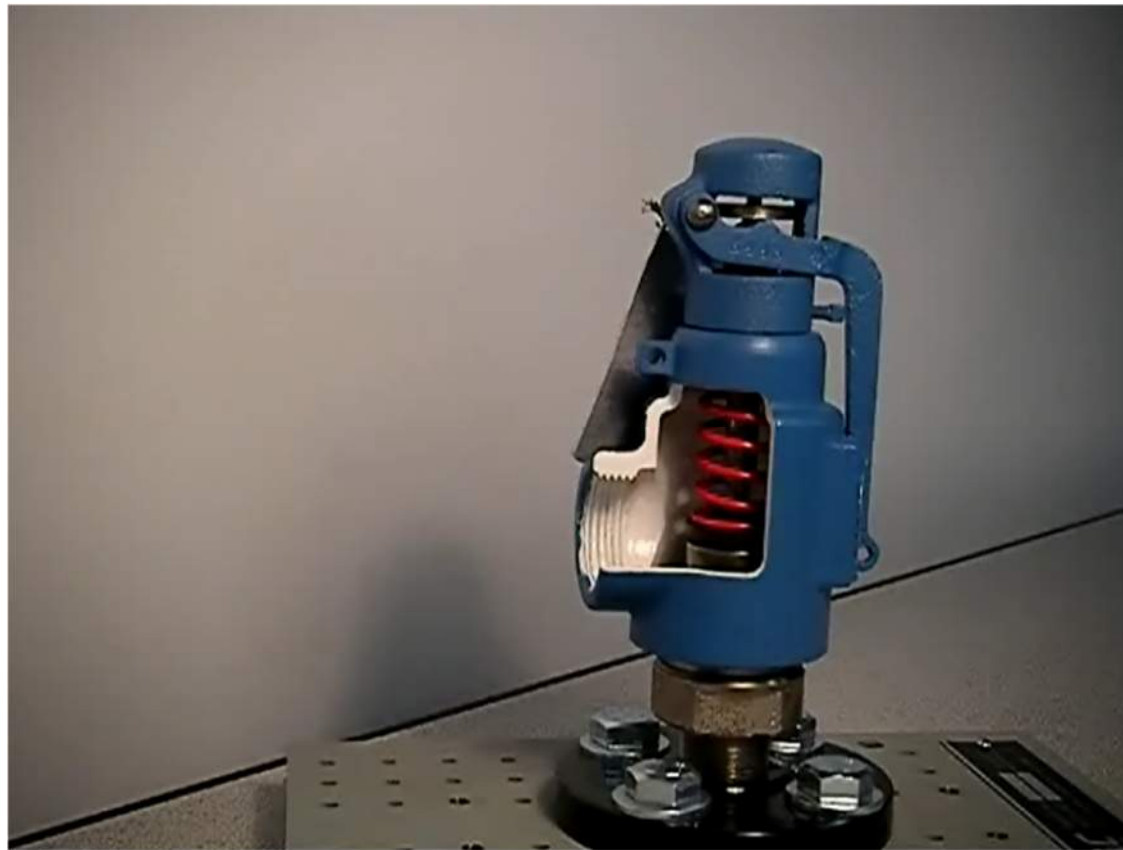
Disk lifts against a spring to allow flow up to a specified pressure

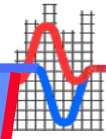
Typically includes a test lever

Pressure Reducing Valve



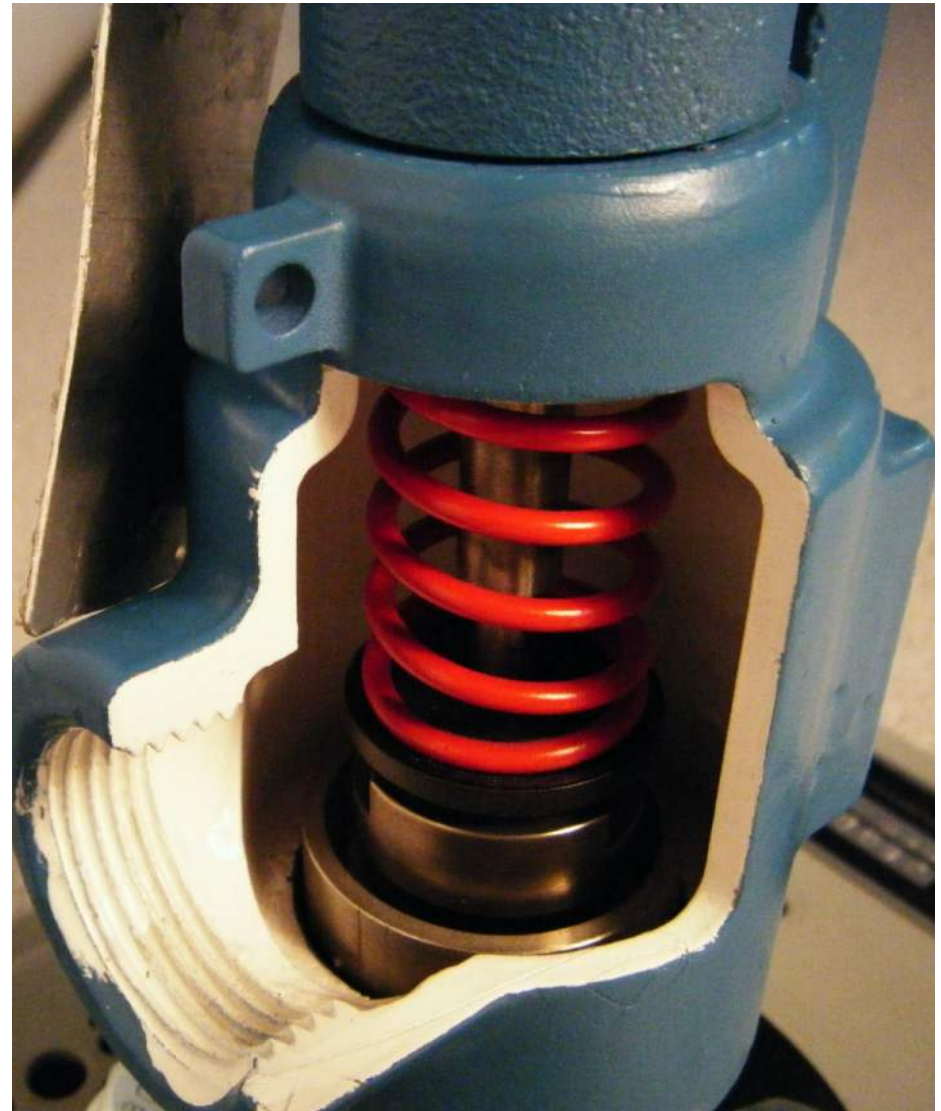
Animation of valve operation.





PRV(cont'd)

Spring over valve piston





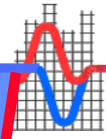
Flow Balancing Valve

System balance is important, but there is a cost associated with using a balancing valve

Multi-purpose or "triple-duty" valves may, or may not, be a good solution



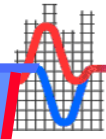
Image from www.BellGossett.com



Flow Limiting Valve

Flow limiters prevent exceeding a given maximum flow rate.

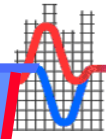




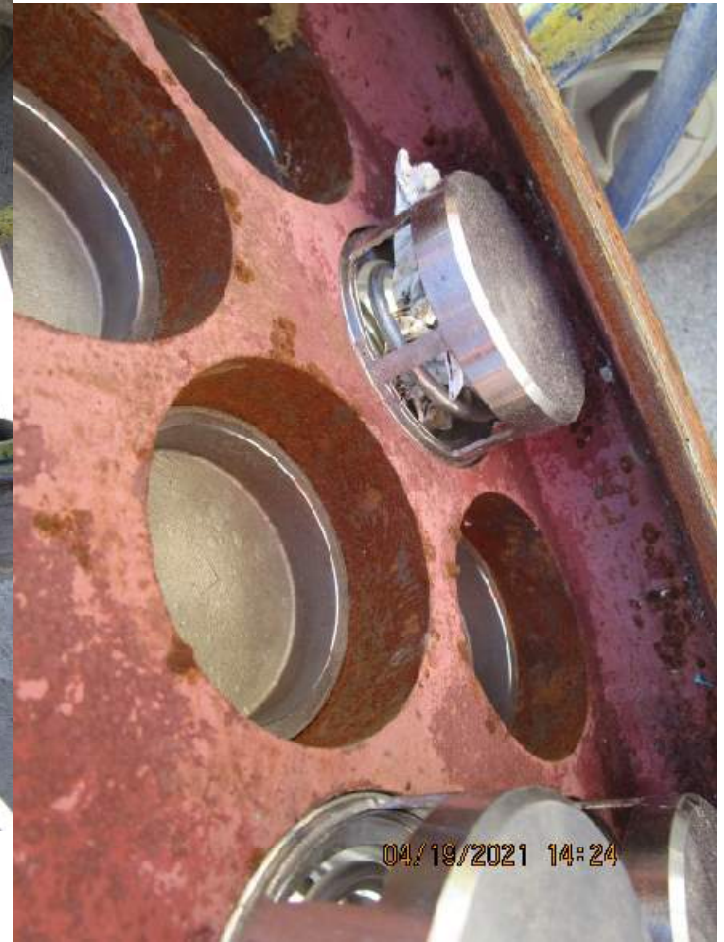
Flow Limiting Valve

Flow limiters prevent exceeding a given maximum flow rate.

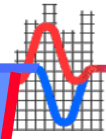




Flow Limiting Valve



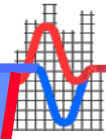
Ported cylinders are spring-actuated to deliver design flow.



Flow Limiting Valve



Ported cylinders are spring-actuated to deliver design flow.

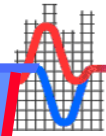


Flow Limiting Valve

Here's a flow limiter installed on a condenser water line serving a centrifugal chiller.

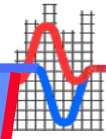


Flow Limiting Valve



Note the design flow rate of 2,805 gpm on the manufacturer's valve tag.



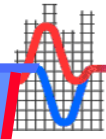


Flow Control Valve

Any valve used to modulate flow

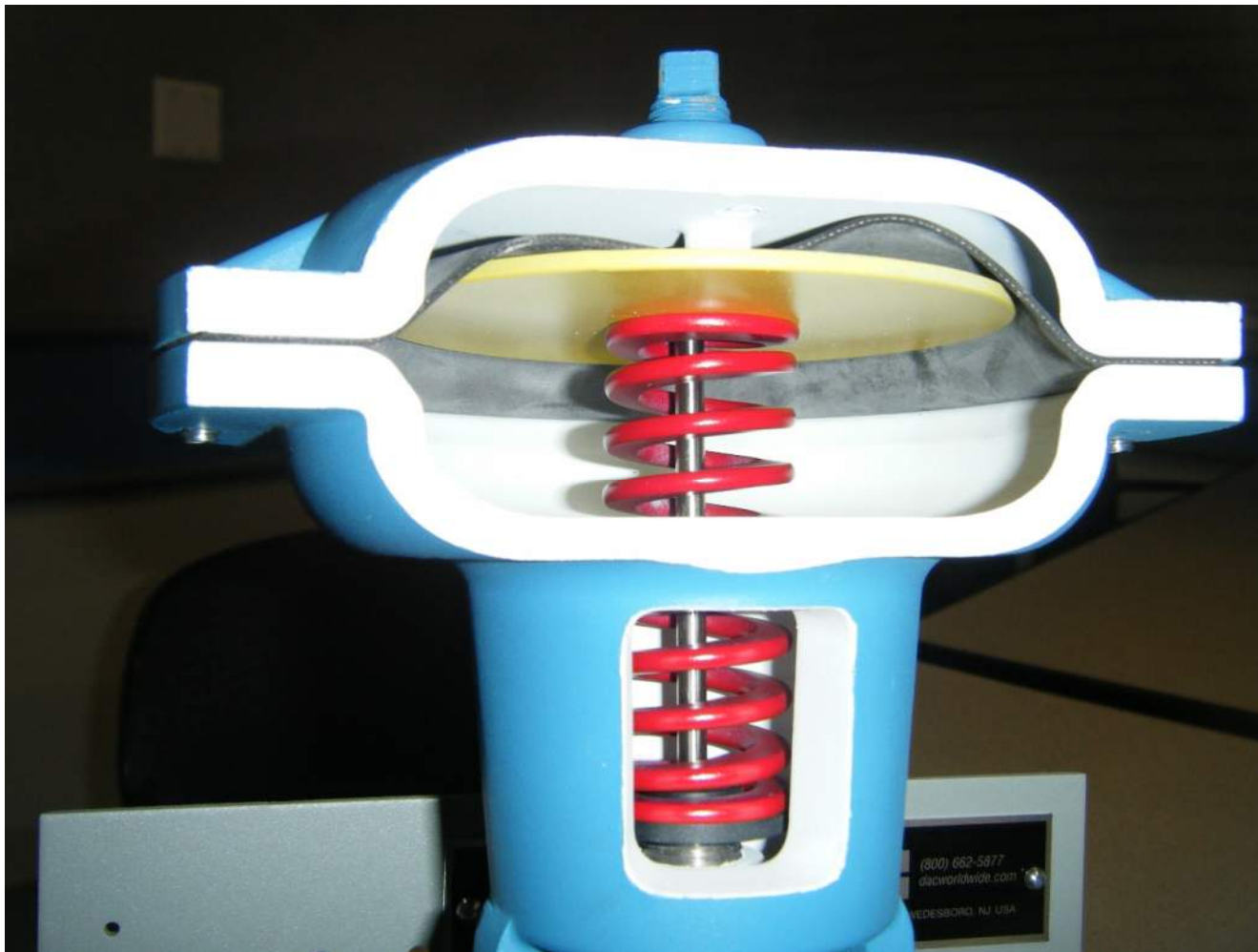
Actuator can be pneumatic as shown
in this picture
, electric, or electronic

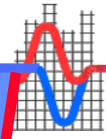




Flow Control Valve (cont'd)

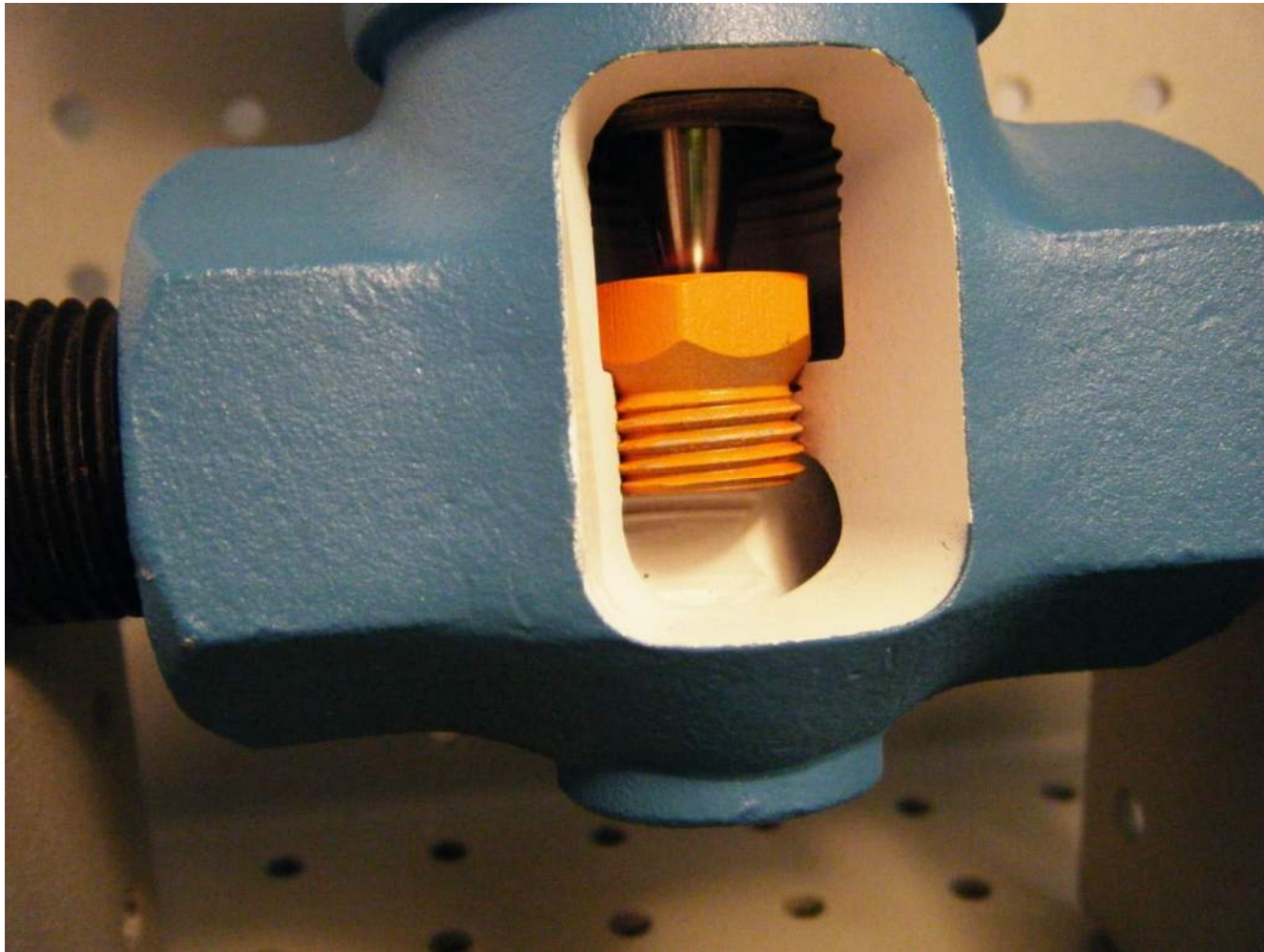
Pneumatic actuator disk and spring

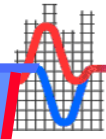




Flow Control Valve (cont'd)

Valve seat



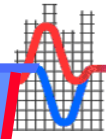


Flow Control Valve (cont'd)



Selection of the proper control valve is critical to maintaining efficient system operation

E.g., what's the C_v ?



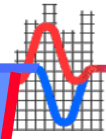
Flow Control Valve (cont'd)

Cv Defined:

The volume of water flowing (gpm) at 60 °F that will result in a pressure drop of 1 psi across the valve.

$$C_v = Q \sqrt{\frac{SG}{\Delta P}}$$

Note: *SG* = specific gravity

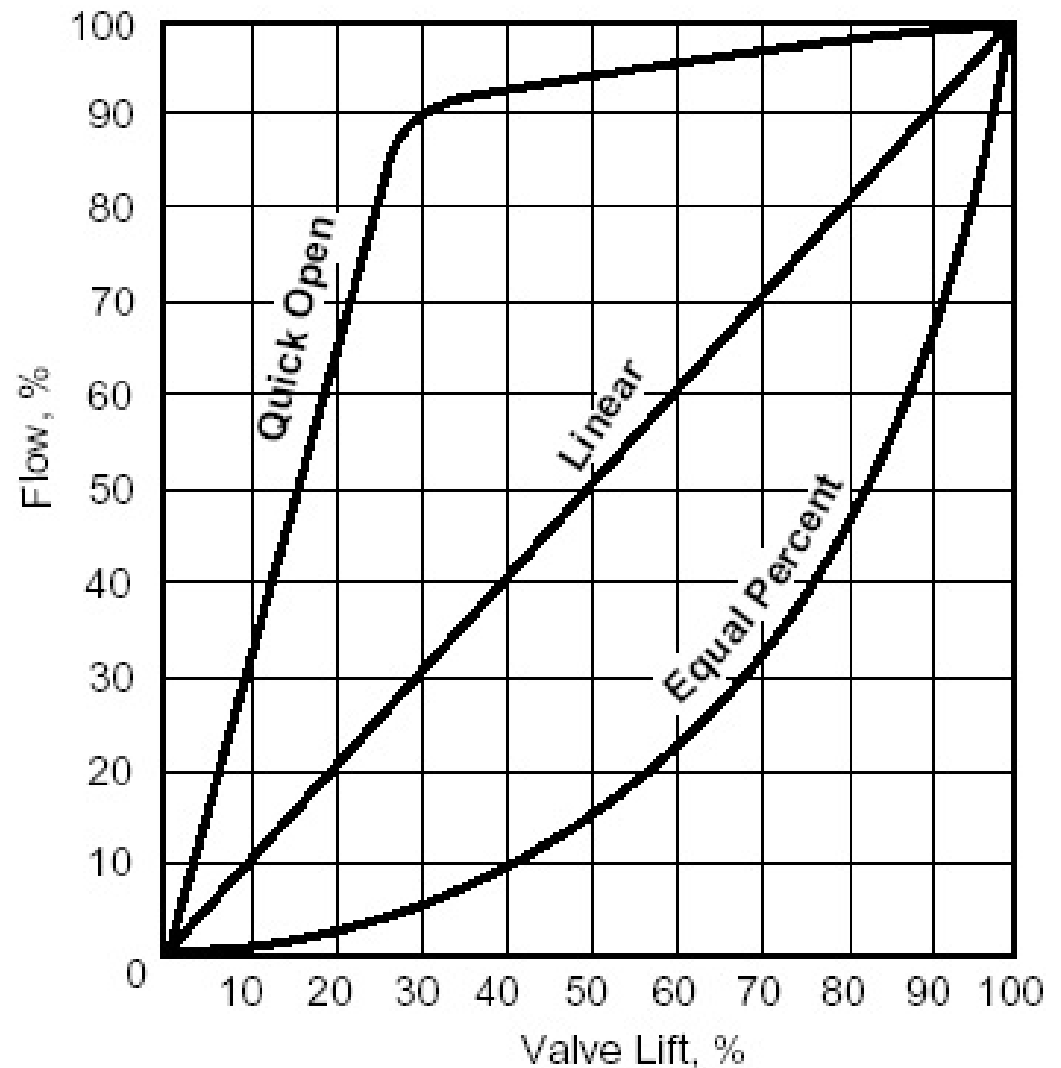


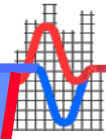
Flow Control Valve (cont'd)

Control valves have characterized ports that produce different flow responses to valve position:

- Quick opening
- Linear
- Equal percentage

Equal percentage valves may be selected to deliver linear flow control to an air coil in conjunction with the actuator operation.



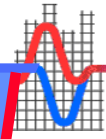


3-Way Valve

Applications:

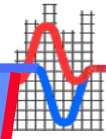
- Mixing
- Diverting





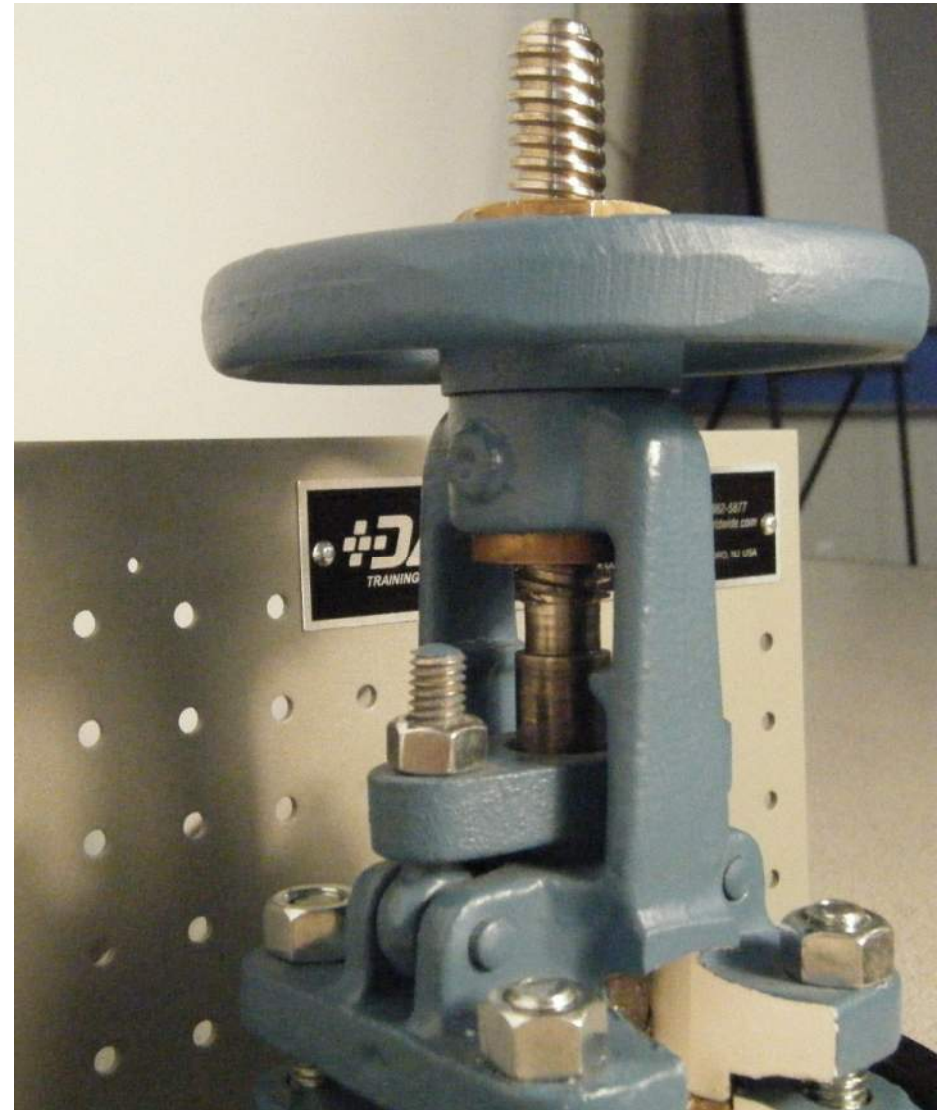
Key Valve Components

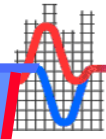
- **Body**
- **Bonnet**
- **Seat**
- **Disk**
- **Stem**
- **Packing**



Bonnet Types

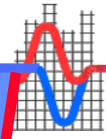
- **Various connection options**
 - Threaded
 - Union connection; connects unthreaded bonnet to valve body
- **Bolted connection**
 - Utilizes a gasket to maintain seal
- **Pressure seal connection**
 - High pressure applications
- **Welded connection**
 - Bonnet welded to valve body
 - Disposable valves





Valve Trim

- **Trim Components**
 - Disk
 - Seat
 - Stem (most, but not all, valves)
- **Function**
 - Allow for flow control
 - Disk-to-seat interface determines flow performance
 - Disk must withstand full system pressure if closed and outlet is opened to atmosphere
 - Disk shape varies



Valve Trim

▣ Stem designs

▣ ISRS

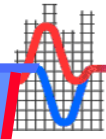
- ▣ Inside screw rising stem
- ▣ Stem threads in contact with fluid moving through valve

▣ NRS

- ▣ Non-rising stem
- ▣ Stem threads turn into disk
- ▣ Stem threads in contact with fluid moving through valve

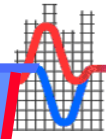
▣ OS&Y

- ▣ Outside stem and yoke
- ▣ Stem threads are outside of valve
- ▣ Stem threads exposed to outside environment



Valve Materials

- **Aluminum** ; -325 to 400 °F; <300 psig
- **Brass** ; -400 to 450 °F; <800 psig
- **Bronze** ; -400 to 550 °F; <300 psig
- **Cast Iron** ; -20 to 410 °F; <200 psig
- **Cast Steel** ; -20 to 1,000 °F;
<6,000 psig
- **Ductile Iron** ; -20 to 650 °F;
<8,000 psig
- **Forged Steel** ; -20 to 850 °F; <5,000 psig

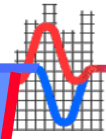


Valve Selection - Size

- **Size defined by pipe connection sizes**

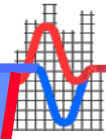
- **Availability based on type, body material, and pressure class**

- **Body material and available sizes**
 - **Bronze ; 1/8" to 3"**
 - **Cast Iron ; 2" to 30"**
 - **Forged Steel ; 1/4" to 3" (some types up to 24")**
 - **Cast Steel ; 2" to 30"**



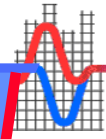
Valve Pressure Classes

- **Greater ability to withstand pressure = higher pressure class number**
 - Class number often equated to psi
 - Misleading as actual ability may vary
- **Typical pressure classes assigned by material**
 - 125 ; bronze, cast iron
 - 150 ; bronze, cast iron, steel
 - 200 ; bronze
 - 250 ; cast iron
 - 300 ; bronze, steel
 - 400 up to 4,500 ; steel



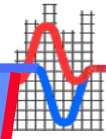
Valve Working Pressure

- Pressure ratings determined by **ASME**
- Stress tolerance decreases as operating temperature increases



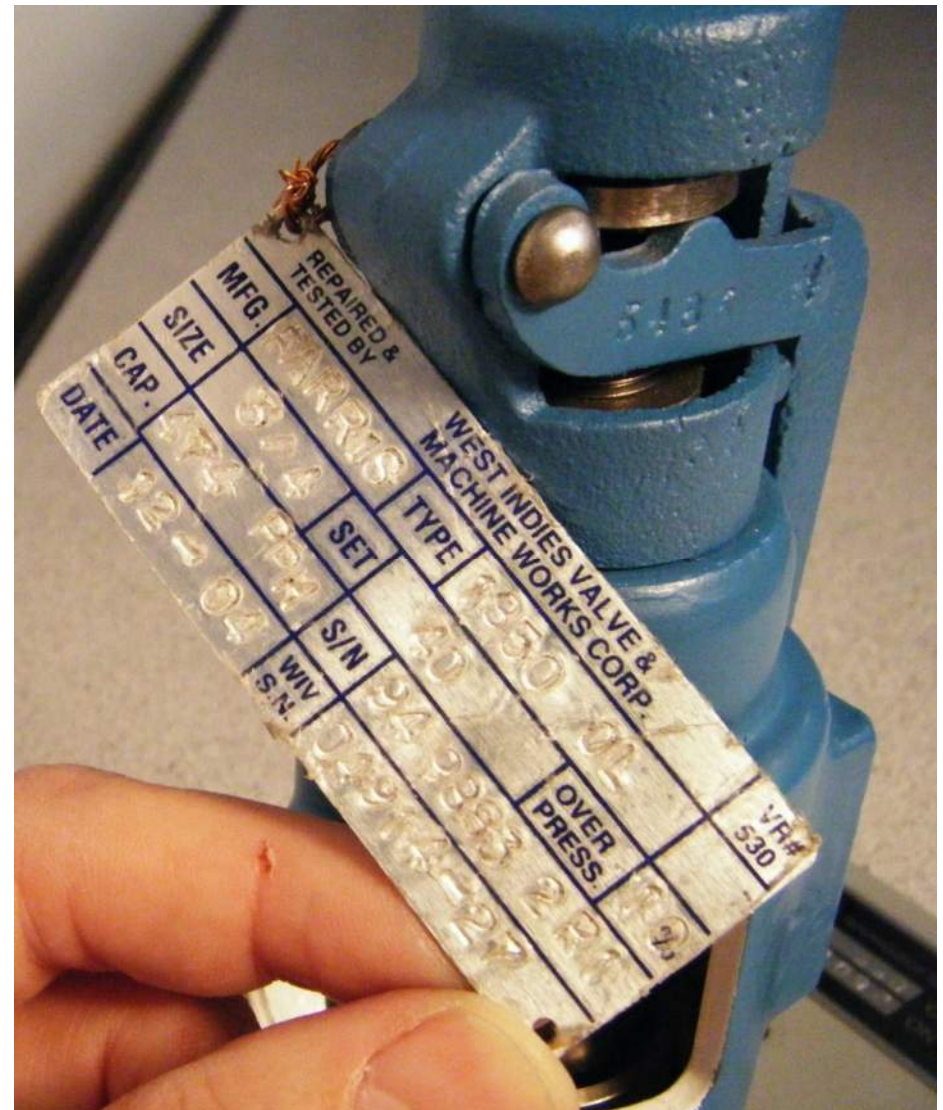
Valve Working Pressure (cont'd)

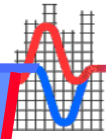
- Working Pressure = actual pressure limit of the valve at a prescribed operating temperature
- Typical working pressure assigned by material at defined temperature
- Example for Class 150 carbon steel valve
 - If $T = 200\text{ }^{\circ}\text{F}$; then $(P)_w = 260\text{ psig}$
 - If $T = 600\text{ }^{\circ}\text{F}$; then $(P)_w = 140\text{ psig}$
 - If $T = 1,000\text{ }^{\circ}\text{F}$; then $(P)_w = 20\text{ psig !}$



Valve Nameplate Data

- Pressure class markings
- Intended use
- May have multiple classifications; e.g.:
 - Maximum operating steam pressure class, "S"
 - ... or "SP" for steam pressure
 - ... or "SWP" for steam working pressure
 - AND an ambient, -20 to 100 °F, temperature rating, indicated by "WOG" (waste, oil, gas) or "CWP" (cold working pressure)

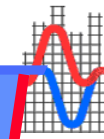




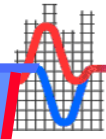
Summary - Valve Selection

- ▣ **Identify Usage**
- ▣ **Identify Component Materials Needed**
- ▣ **Select Type**
- ▣ **Select Trim**
- ▣ **Optimize**
 - ▣ **Minimize pressure loss**
 - ▣ **Locate for ease of maintenance**

Summary - Valve Types and Service



- **Ball** - start/stop; direction change
- **Butterfly** - start/stop; throttling
- **Gate** - start/stop
- **Plug** - start/stop; direction change
- **Globe** - start/stop; throttling
- **Check** - prevent reverse flow
- **Relief** - pressure and temperature limiting
- **Control** - start/stop; throttling



Resources

- ASHRAE Handbooks
- Stojkov, Brent T., The Valve Primer. New York, NY: Industrial Press Inc., 1997
- Design Assistance Corporation, Valve Principles Training Program, Course 251-500, 1998, revised 9-14-2007
- .. and, of course, the internet for access to manufacturer's websites and other engineering sites