CAE 438/538 Control of Building Environmental Systems

Fall 2021

September 14, 2021

Control Devices: Dampers and Valves (1)

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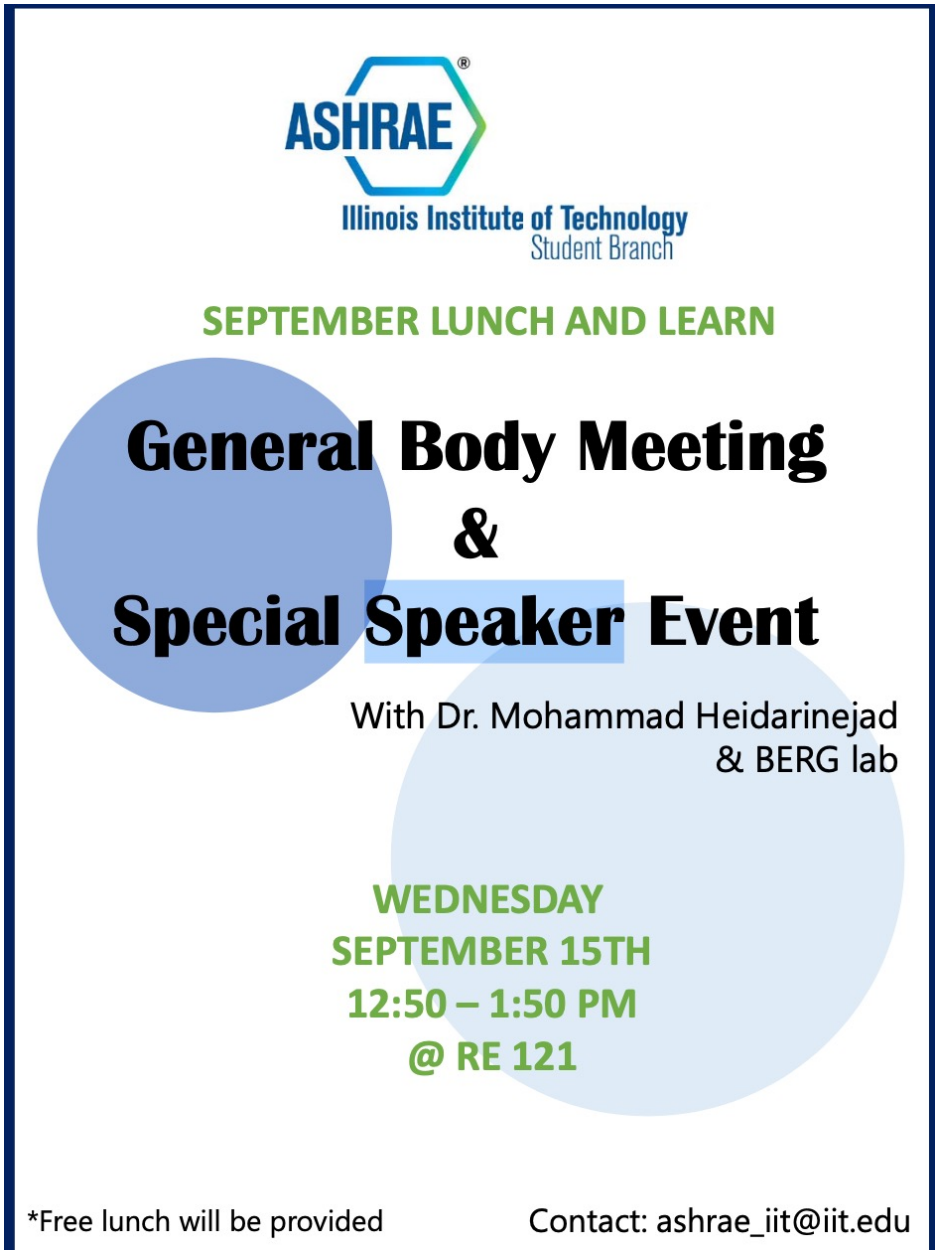
ANNOUNCEMENT

Announcements



Announcements

46 Society Scholarships Available for 2022-2023

As students return to school this fall, please let them know that scholarship money is available from ASHRAE to help them further their education in HVAC&R engineering & technology as it pertains to the built environment. Scholarships range from $3,000 to $10,000. Over the course of 32 years the Society has awarded close to $3 million to 450+ deserving students. For a complete list of scholarships, eligibility requirements, and application, please visit **www.ashrae.org/scholarships** and share the link with qualified and interested students.

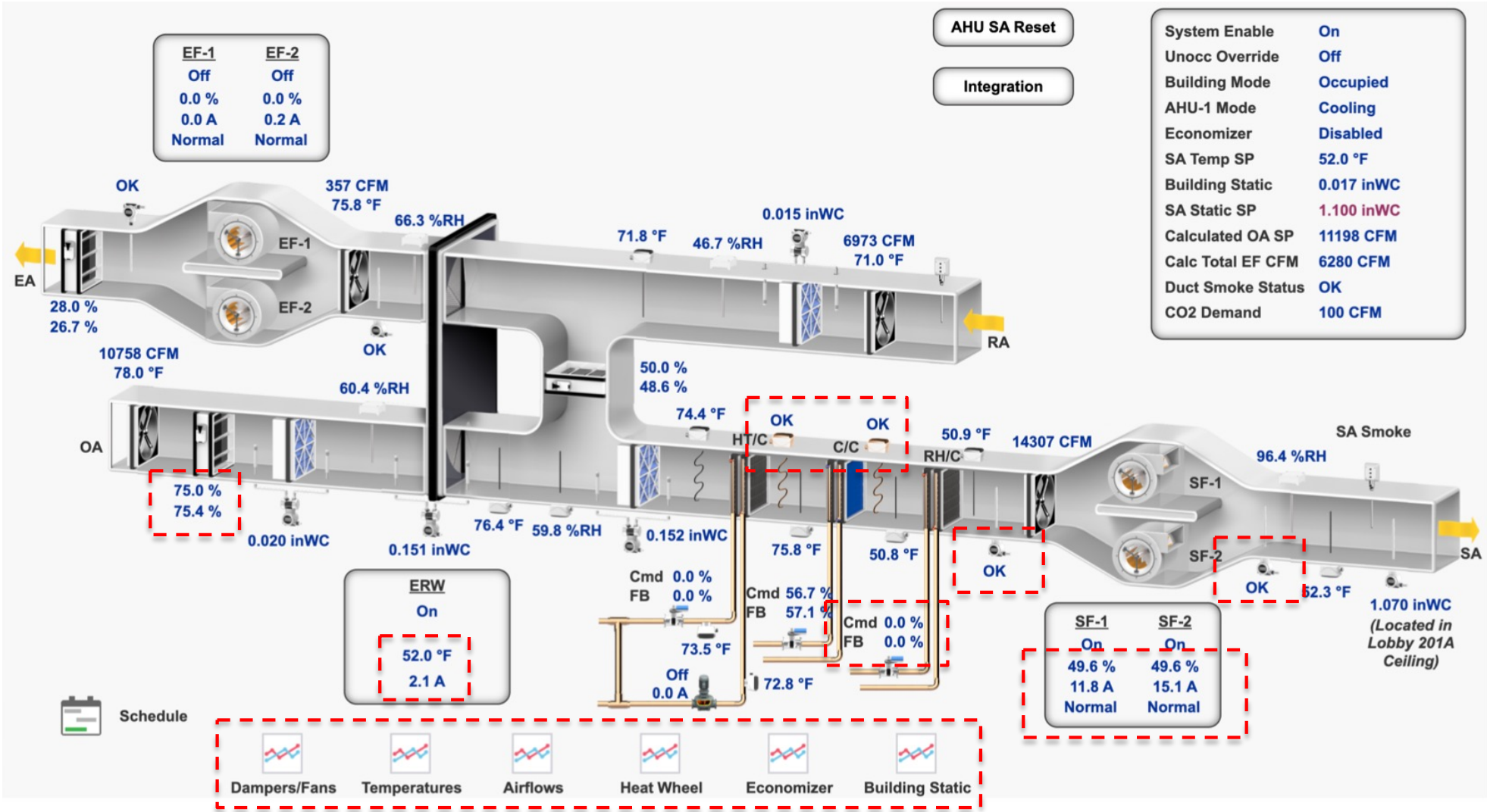
- 16 Undergraduate Engineering Scholarships - $3,000 - $10,000 each. **Now accepting applications.**
- 19 Regional/Chapter & University-specific Scholarships - $3,000 - $5,000 each. **New this year, The Rusty & Debbie Hoffman Family Scholarship. Now accepting applications.**
- 6 Engineering Technology Scholarships - $5,000 - $10,000 each. **Now accepting applications.**
- 1 Freshman Engineering Scholarship - $5,000
- 4 High School Senior Scholarships - $3,000 each

https://www.ashrae.org/communities/student-zone/scholarships-and-grants/scholarship-program

ASSIGNMENT

Assignment

- Review of the graphic schematic:



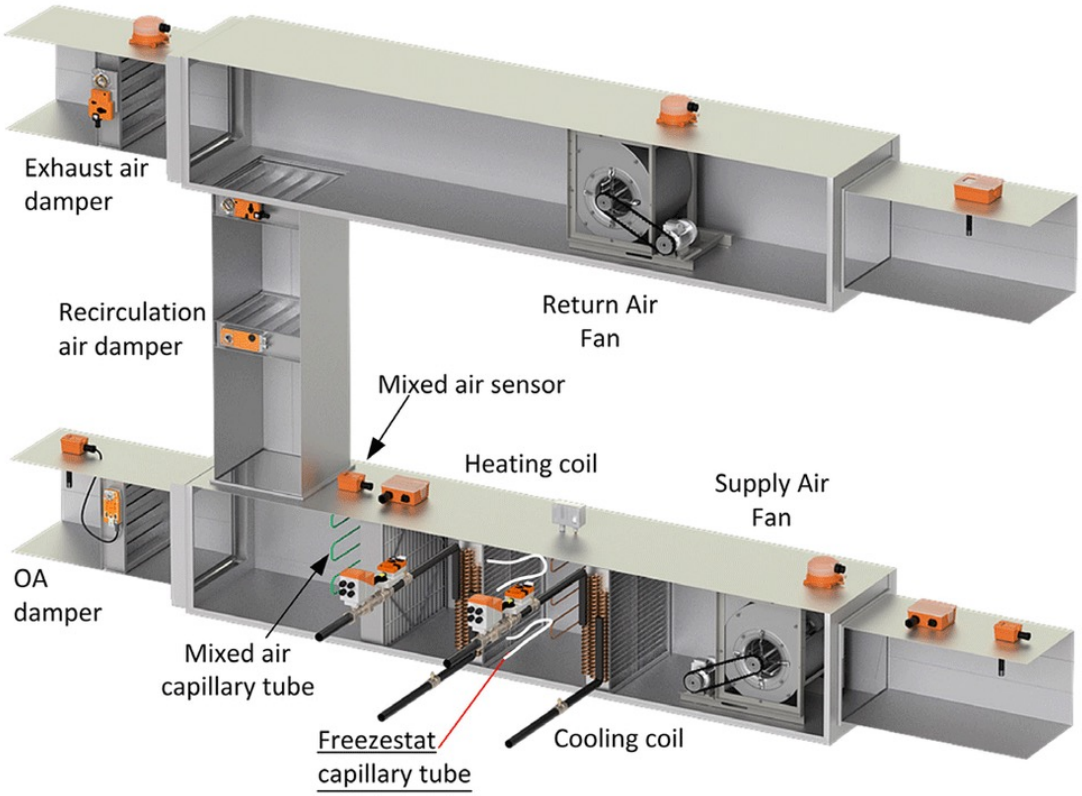
Assignment

- Low limit freeze protection switch:
  - ❑ Prevent cooling coils from freezing in low temperature
  - ❑ Mounted between heating and cooling coils
  - ❑ Mounted on the supply side
  - ❑ It is usually set at a fixed safety value (set point) which can be set as low as 34°F (1°C)
  - ❑ See this link: https://www.youtube.com/watch?v=znktO3tMSas

https://www.dwyer-inst.com/Product/Temperature/Switches/Mechanical/SeriesDFS2

Assignment

- Freezestat:
  - ❑ Present water coil low-temperature protection
  - ❑ Freezestat set point typically is 37°F (3°C)
  - ❑ See the link: https://www.youtube.com/watch?v=NJkJfKxaJT4



https://www.hpac.com/air-conditioning/article/20929880/freezestat-control-methods-protect-coils

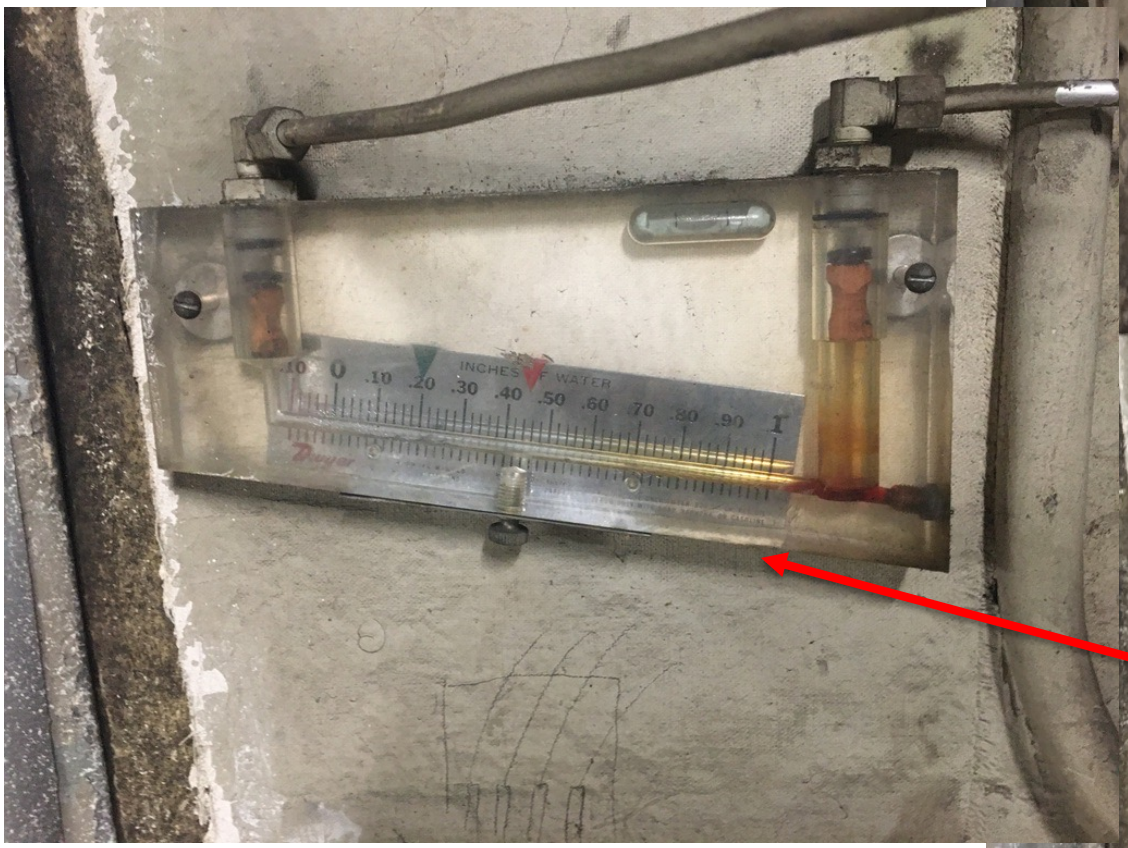
Assignment

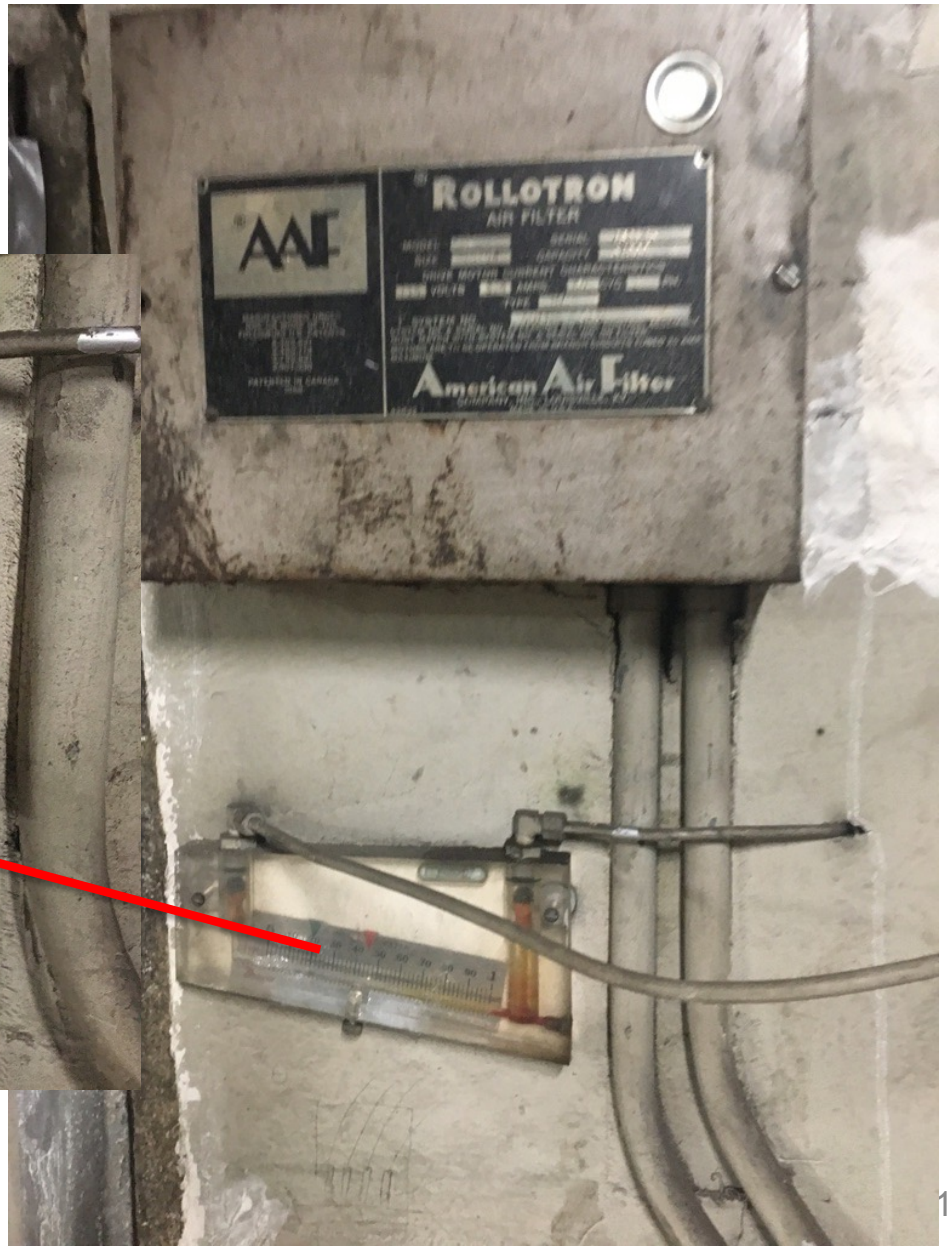
- Differential pressure switches
  - Low static pressure and high static pressure
  - Good resources:
    - https://www.dwyer-inst.com/articles/?Action=View&ArticleID=6
    - https://www.dwyer-inst.com/Product/Pressure/DifferentialPressure/Switches/Series1831

RECAP

Recap

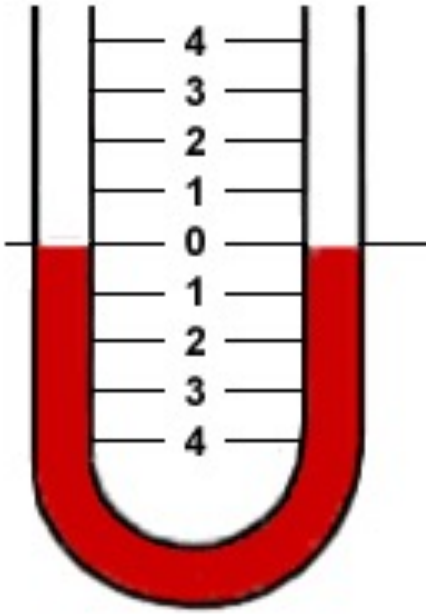
- What is this?

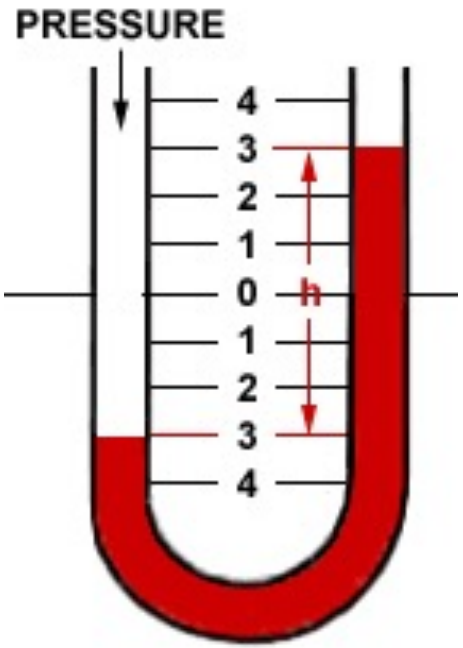


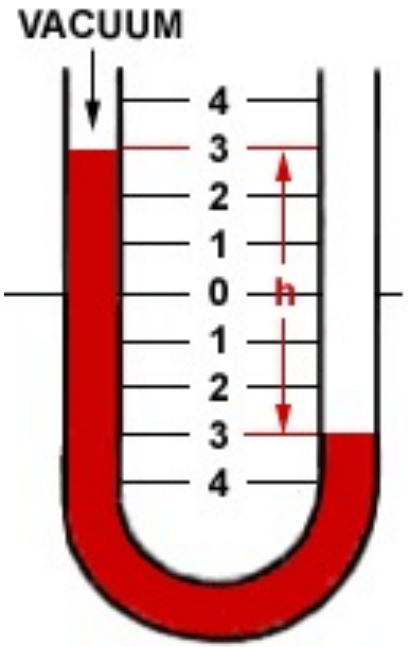


Recap

- What is a manometer?



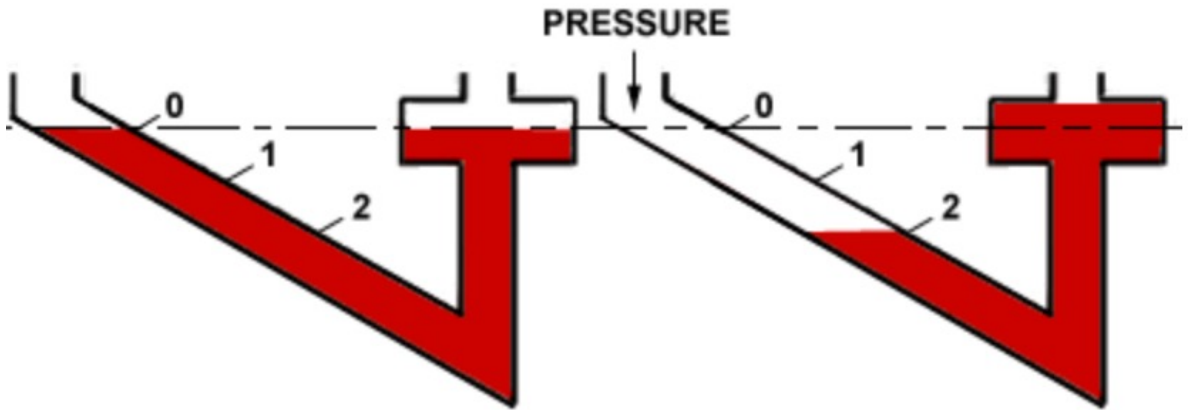




https://www.dwyer-inst.com/ApplicationGuides/?ID=11

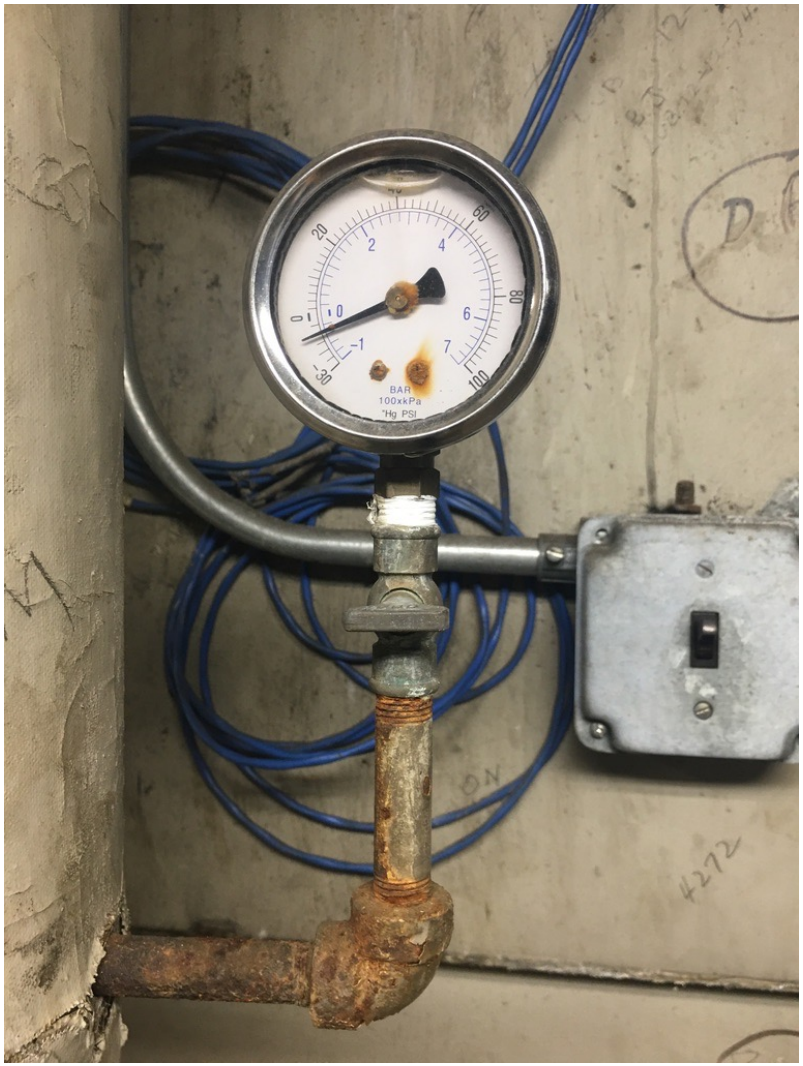
Recap

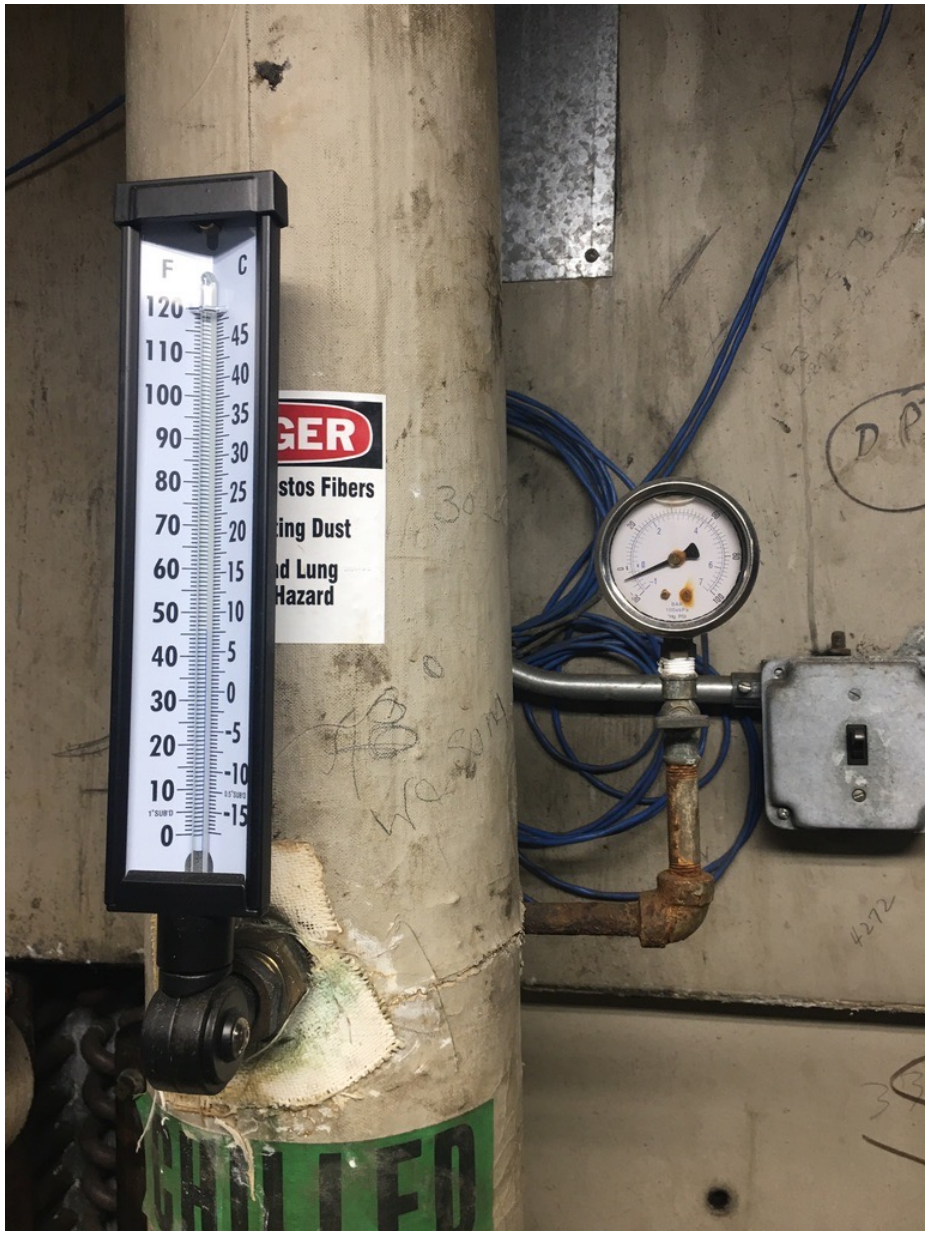
- Why do we use this configuration?



Recap

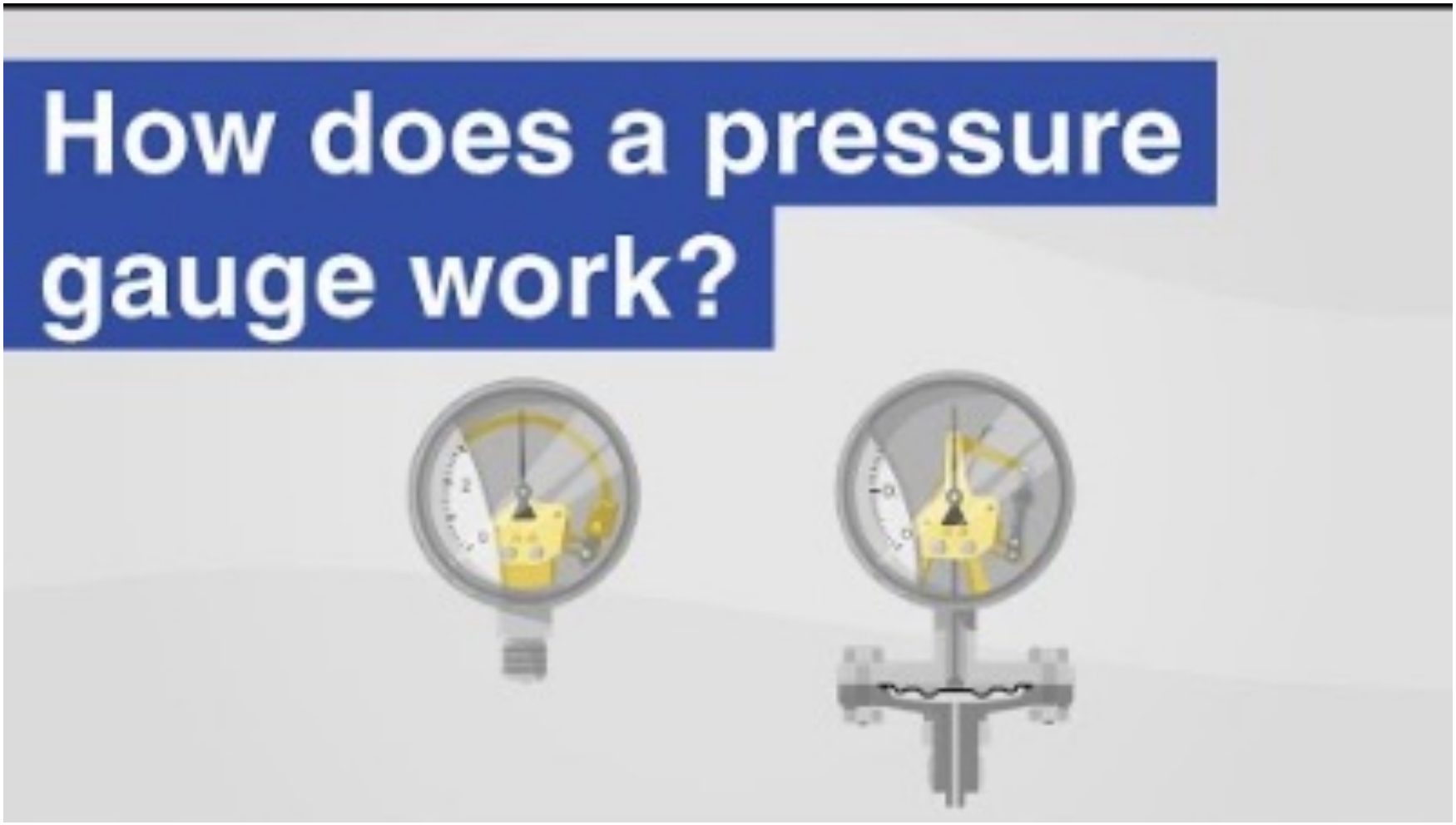
- Bourdon pressure gauge:





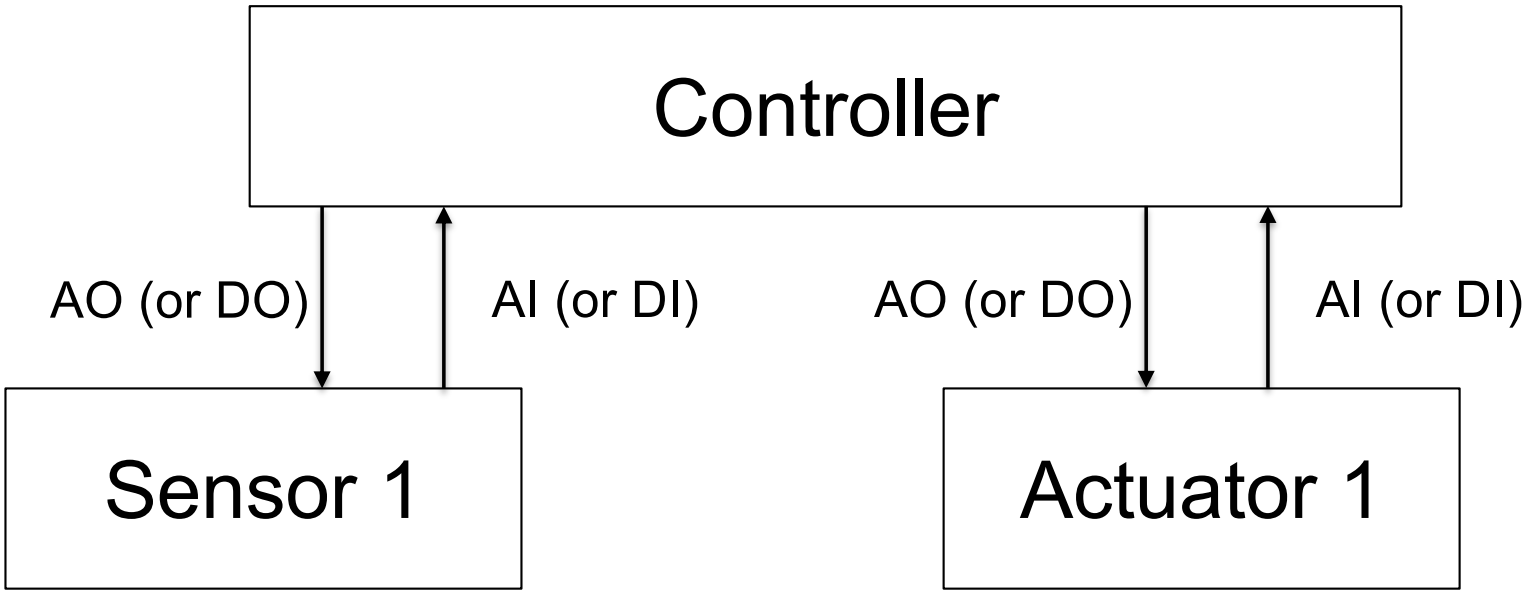
Recap

- Bourdon pressure gauge:

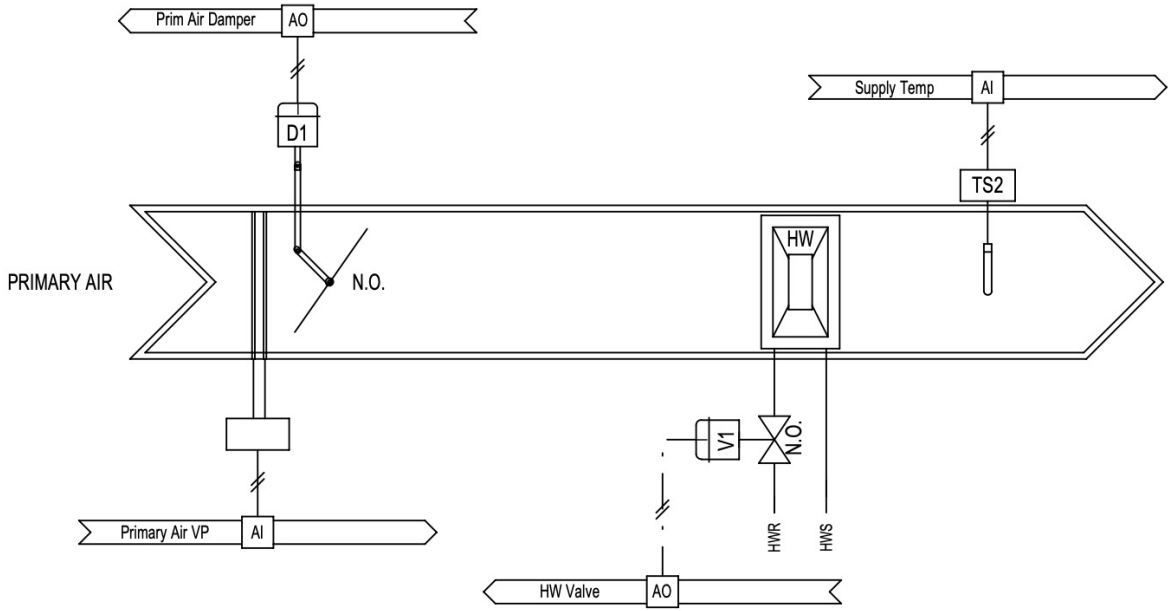


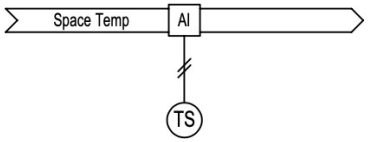
Recap

- We look at the context of building automation system to define inputs and outputs to a controller:



Recap





POINTS LIST							
ADDRESS	POINT DESCRIPTOR	POINT TYPE					REMARKS
		DI	AI	DO	AO	VP	
	Space Temp		◦				Typ. for all VAV Boxes
	Prim Air Damper				◦		Typ. for all VAV Boxes
	Primary Air Flow		◦				Typ. for all VAV Boxes
	Supply Air Temp		◦				Typ. for all VAV Boxes
	HW Heating Valve				◦		Typ. for all VAV Boxes
	Dx Cooling Enable			◦			Typ. for 3 rooms
TOTALS		--	4	--	3		

Recap

- Voltage inputs are:
  - Most common types are:
    - 12 VAC
    - 12 VDC
    - 24 VAC
    - 24 VDC
    - 120 VAC

V: Volts

AC: Alternating Current

DC: Direct Current

Recap

- Analog output:
  - ❑ Can be used to read a variable measurement
  - ❑ Examples are temperature, humidity and pressure sensor (e.g., 4-20 mA, 0-10 volt)

INTRODUCTION TO CONTROLLED DEVICES

Introduction to Controlled Devices

- Closed Loop or Feedback:
  - **Sensor:** measures the controlled variable and transmits to the controller a signal (pneumatic, electric, or electronic)
  - **Controlled device:** is typically a valve, damper, heating element, or variable-speed drive
  - **Controller:** compares this value with the set point and signals to the controlled device for corrective action
    - A controller can be hardware or software
    - A hardware controller is an analog device (e.g., thermostat, humidistat, pressure control) that continuously receives and acts on data
    - A software controller is a digital device (e.g., digital algorithm) that receives and acts on data on a sample-rate basis

Introduction to Controlled Devices

- Controlled devices in the building systems could vary from a wide range of:
  - ❑ Dampers
  - ❑ Valves
  - ❑ Refrigeration compressors
  - ❑ Gas valves
  - ❑ Electric heating elements

What are their application?

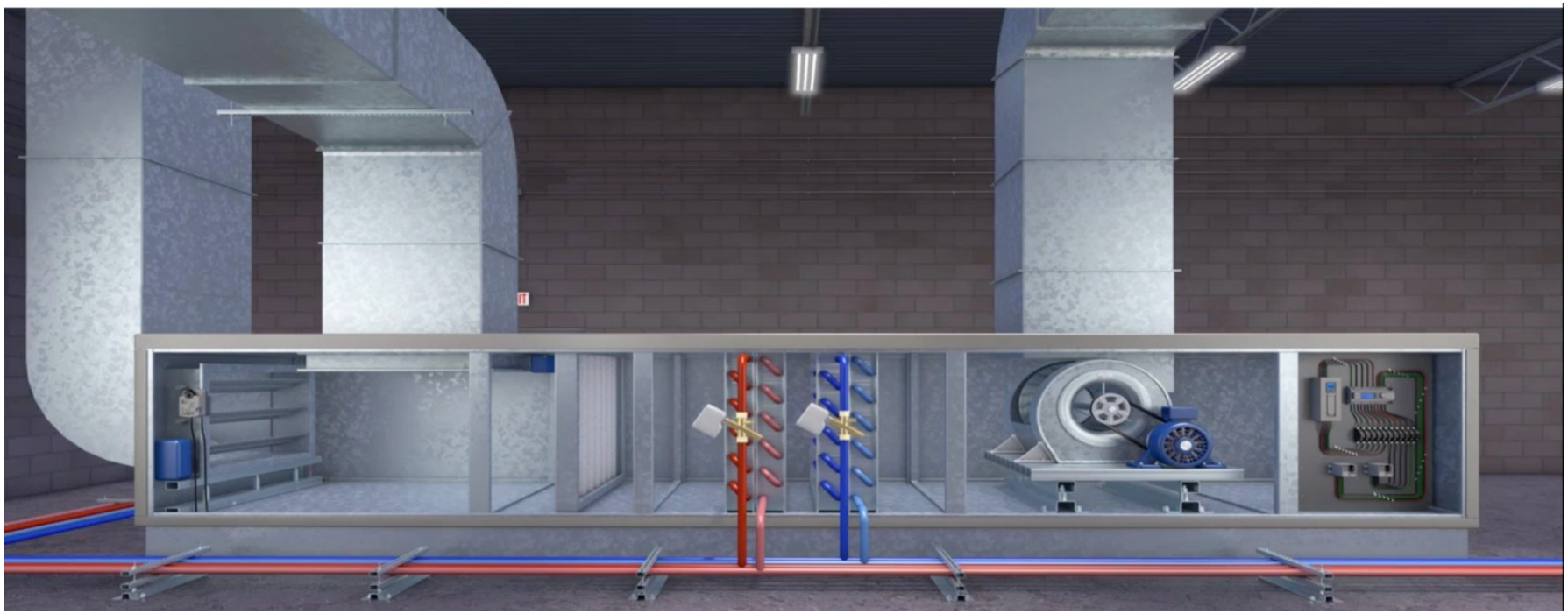
Introduction to Controlled Devices

- Automatic dampers are used in air conditioning and ventilation to control airflow. They may be used:
  - ❑ To modulate control to maintain a controlled variable, such as mixed air temperature or supply air duct static pressure
  - ❑ For two-position control to initiate operation, such as opening and closing
  - ❑ Control outside air dampers when a fan is started

Introduction to Controlled Devices

- Valves are important controlled devices in hydronic systems since they control:
  - ❑ Heat transfer
  - ❑ Flow rates

$$q = 500 \times GPM \times \Delta T$$

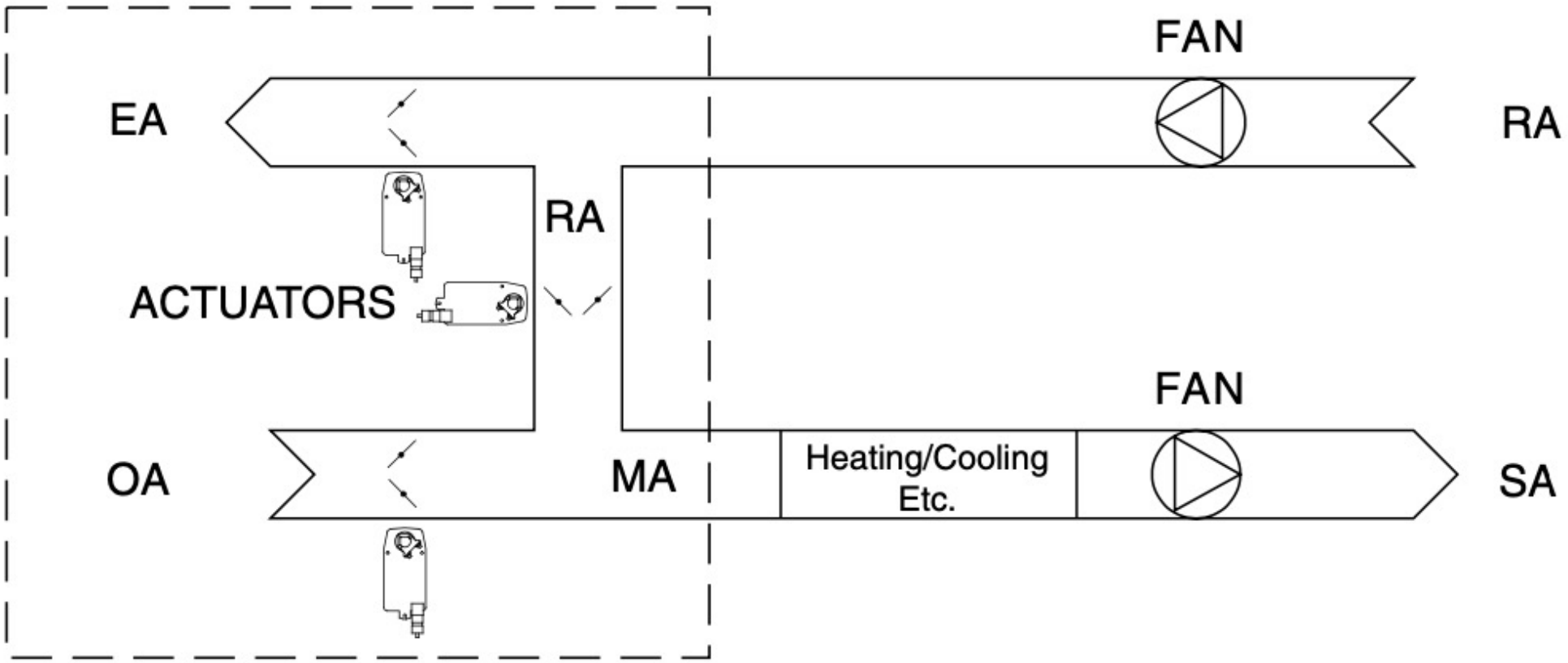


Credit: Siemens

DAMPER CHARACTERISTICS

Damper Characteristics

- Where do we install dampers?



Belimo: Damper actuator applications Guide

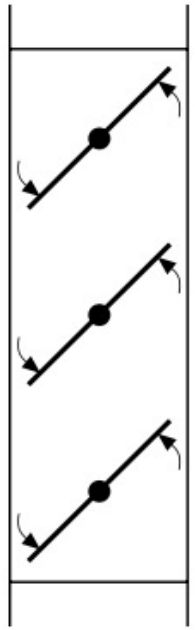
Damper Characteristics

- Geometrical information
  - Damper dimension (e.g., for rectangular (W x H) and the diameter for round dampers)

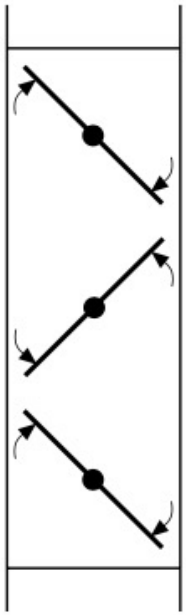
- Material:
  - SAE 304 stainless steel
  - SAE 316 stainless steel
  - Aluminum
  - Galvanized steel
  - Painted steel

Damper Characteristics

- The two main damper types are:
  - ❑ Parallel: Blades move in the same direction
  - ❑ Opposite: Blades next to each other move in the opposite direction

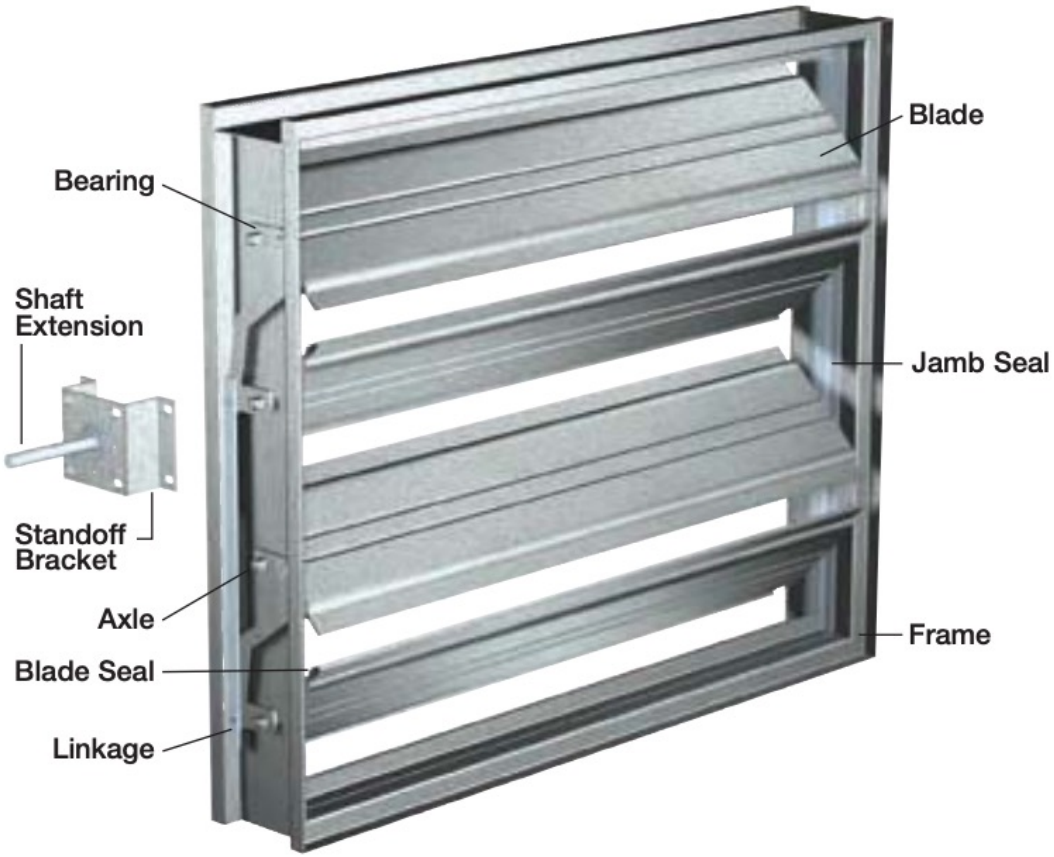


PARALLEL BLADE DAMPER



OPPOSED BLADE DAMPER

Damper Characteristics



https://content.greenheck.com/public/DAMProd/Original/10002/ControlDampers_catalog.pdf

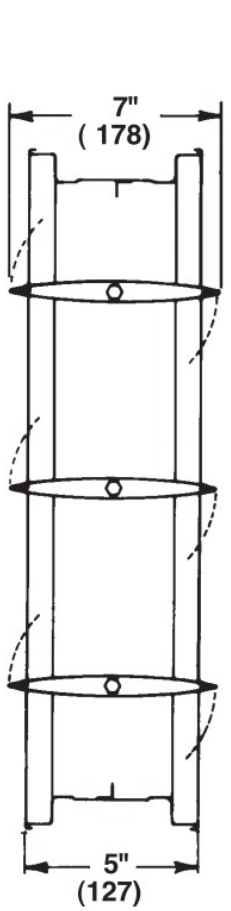
https://www.ruskin.com/doc/Id/153

Damper Characteristics

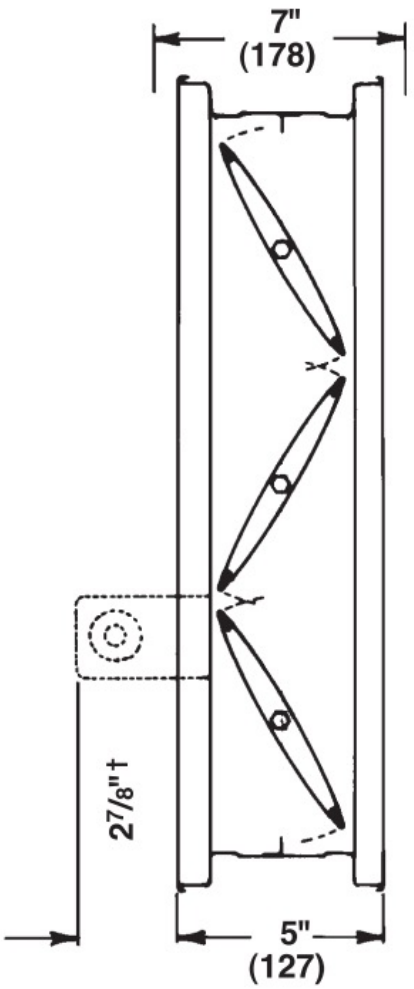
- Multiblade dampers are typically available in two arrangements

  - **Parallel-blade:**
    - Pressure drop of the damper is about 25% or more of the pressure in a subsystem
    - Good for two position (e.g., open or closed)

  - **Opposed-blade:**
    - The pressure drop of the damper is less than 15% of the pressure in a subsystem



PARALLEL BLADE

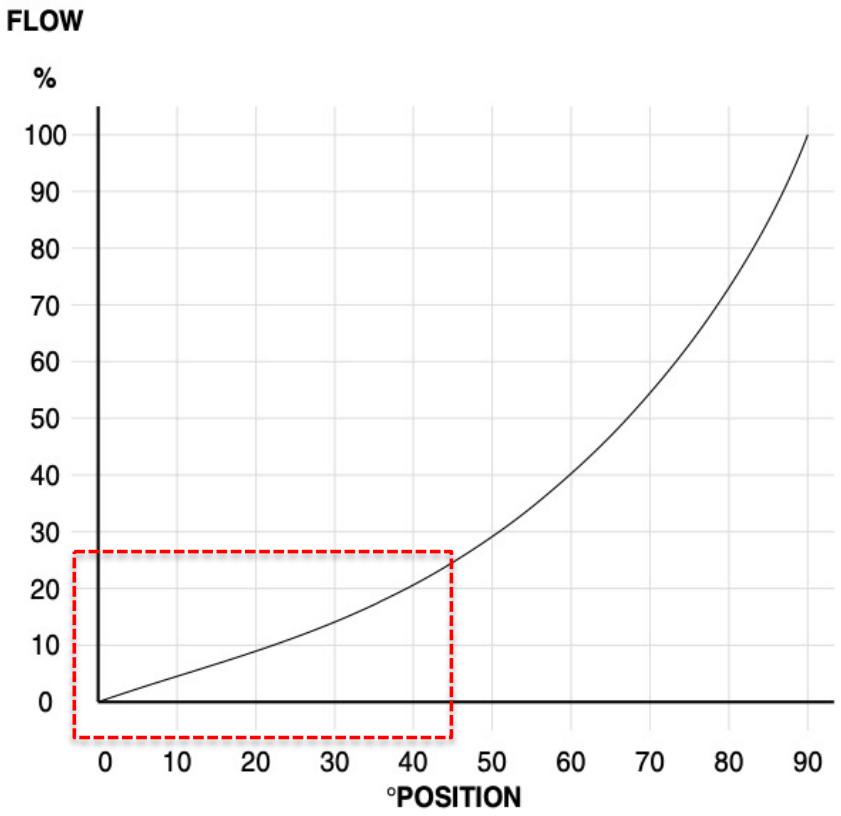


OPPOSED BLADE

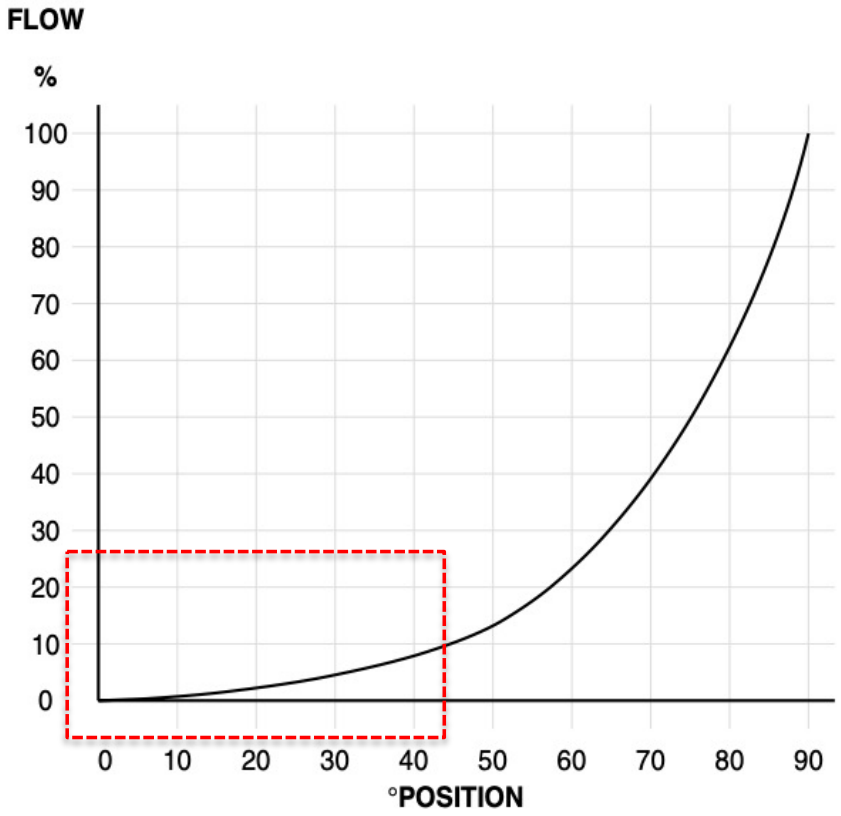
https://www.ruskin.com/doc/Id/153

Damper Characteristics

- Flow characteristics of these two dampers are different:



PARALLEL BLADE DAMPER

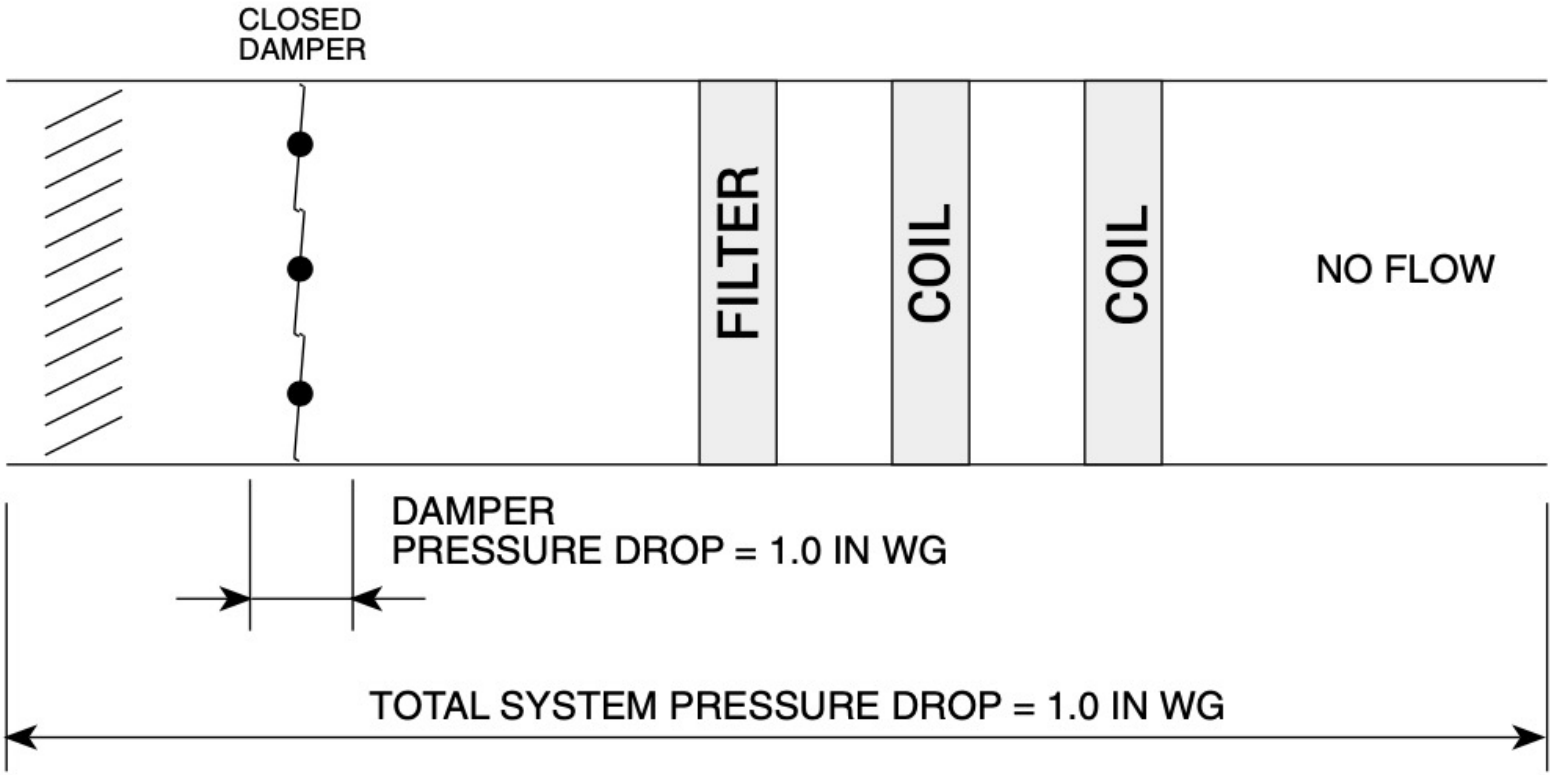


OPPOSED BLADE DAMPER

Belimo: Damper actuator applications Guide

Damper Characteristics

- Damper is NOT the only equipment that affects the flow and pressure drop and the flow characteristics is different.



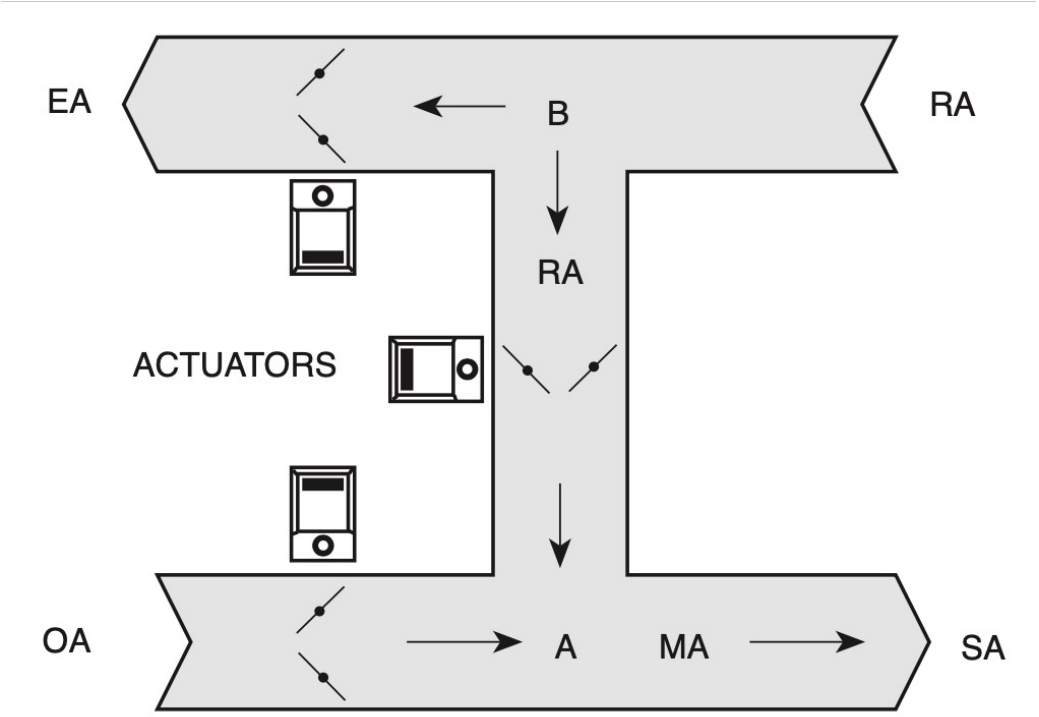
Damper Characteristics

- Damper authority is the ratio of open damper pressure drop to the total pressure drop as follow:

$$Damper\ Authority\ \% = \frac{Open\ Damper\ Pressure\ Drop}{Total\ System\ Pressure\ Drop} \times 100\%$$

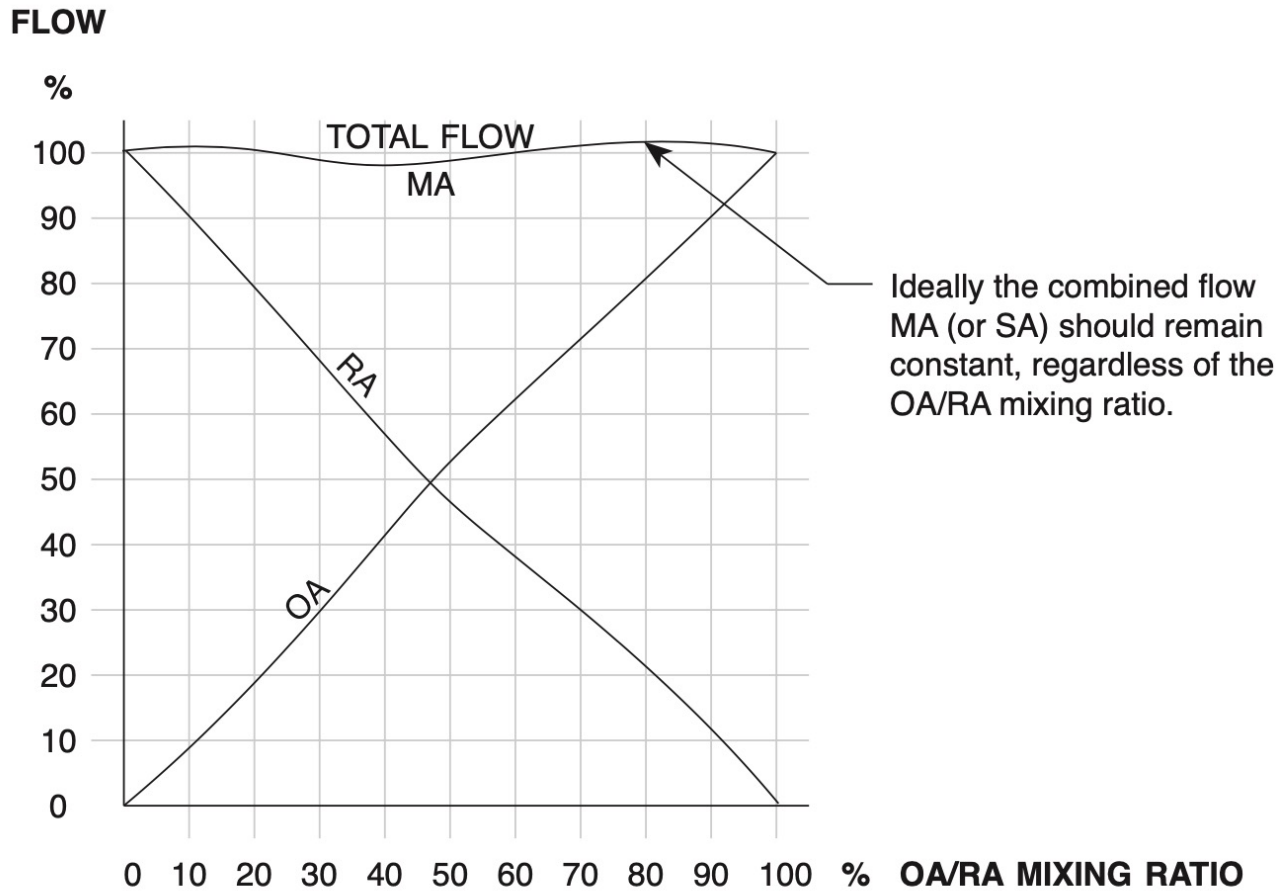
Damper Characteristics

- Make sure to consider the total pressure drop of the flow that the damper controls
- In an ideal situation, what area does control the pressure drop and size of dampers in OA, RA, and EA?



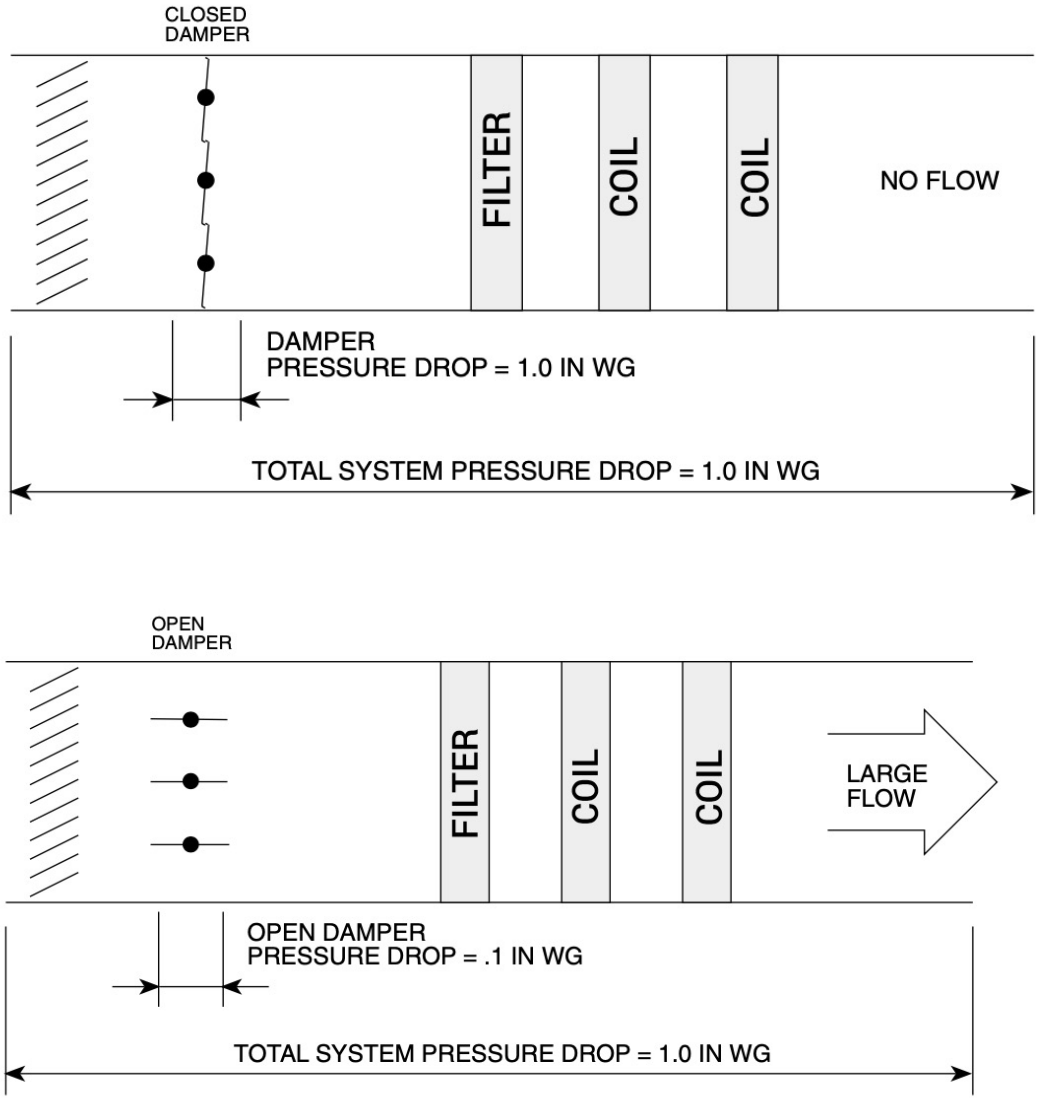
Damper Characteristics

- With properly sizing dampers, their characteristics will complement each other and therefore the flow remains constant



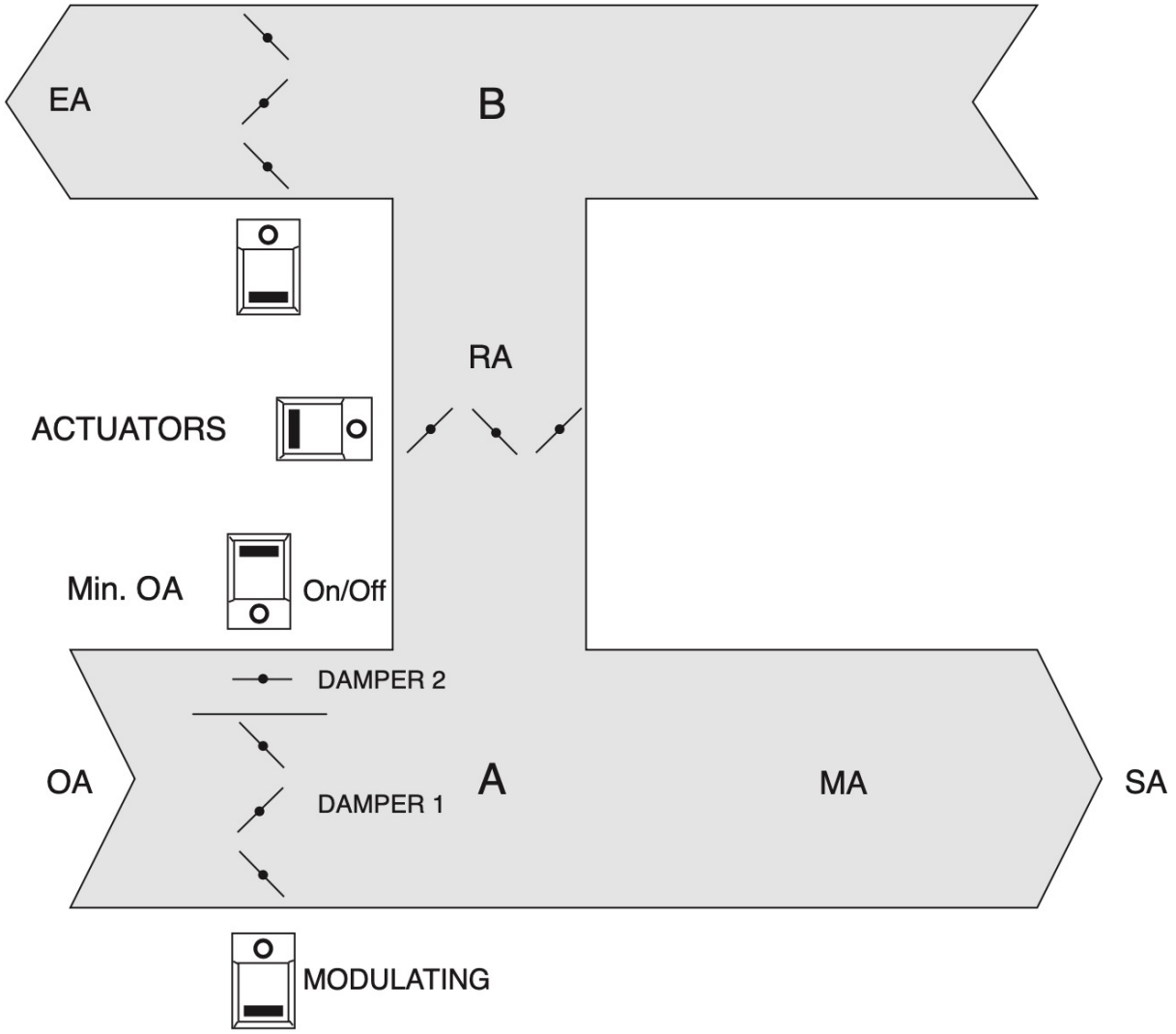
Damper Characteristics

- What's the damper authority here:



Damper Characteristics

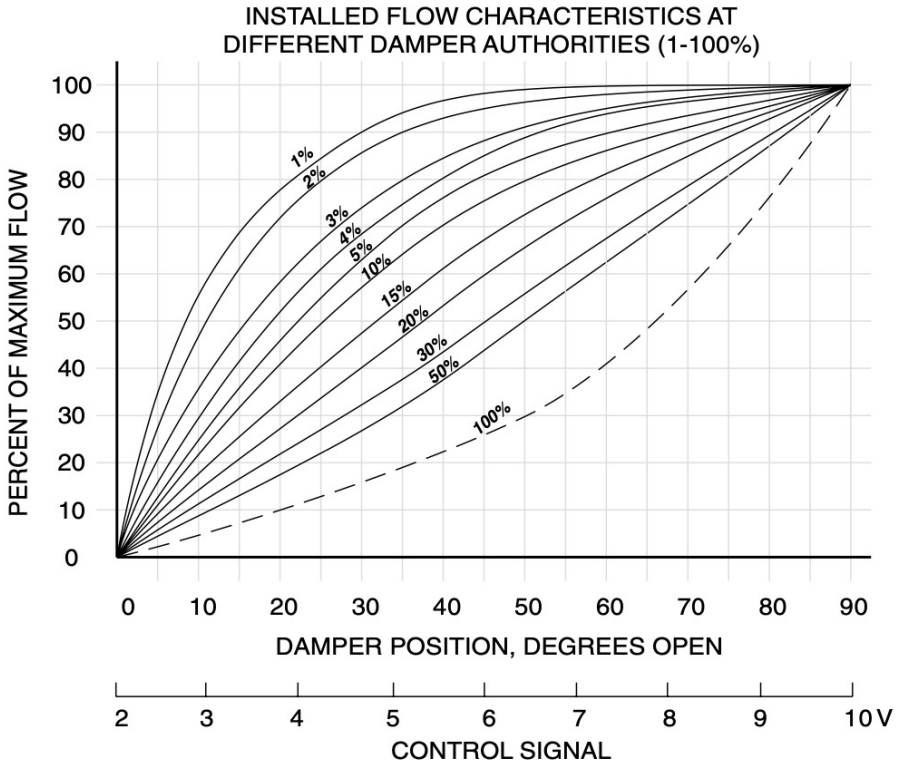
- What do you think about the outdoor air dampers here?

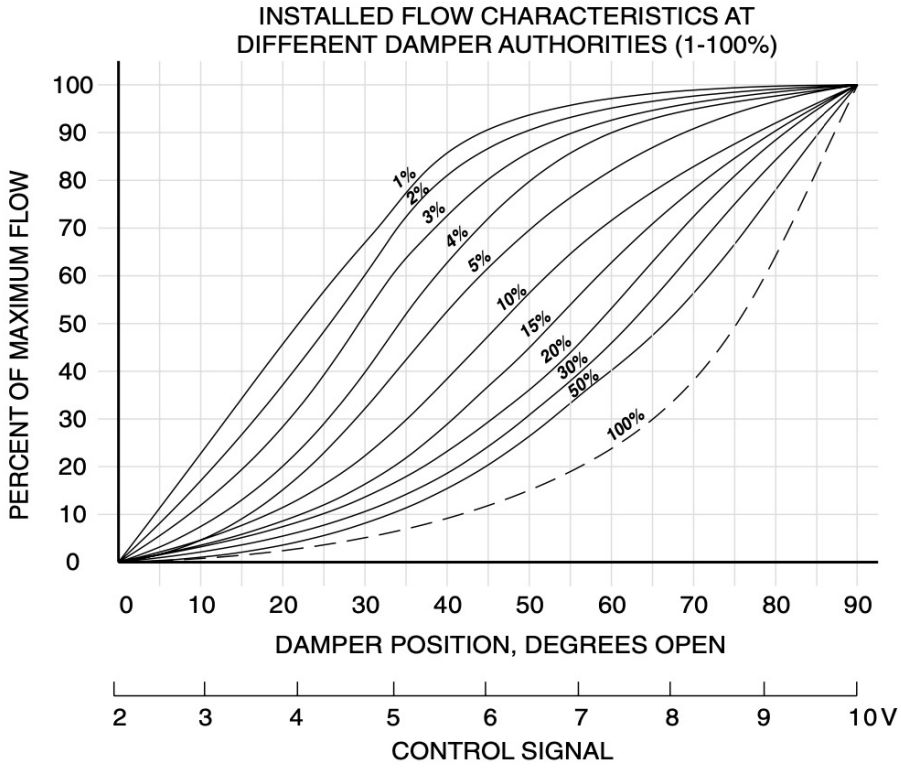


CLASS ACTIVITY

Class Activity

- Consider the two figures for the damper authorities and discuss the pattern?





SIZING DAMPERS

Sizing Dampers

- Sizing of dampers used to follow a similar pressure drop calculations for minor losses
  - ❑ Determine the damper pressure drop
  - ❑ Use the governing equation for the damper type to compute the velocity (this is like a face velocity)
  - ❑ Damper size then can be computed knowing the wide-open damper flow and velocity, and area

$$P_{damper} = C_v \left(\frac{V}{4005}\right)^2$$

Sizing Dampers

- How to calculate the pressure drop using manufacture datasheets:
  - ❑ Fully ducted damper:

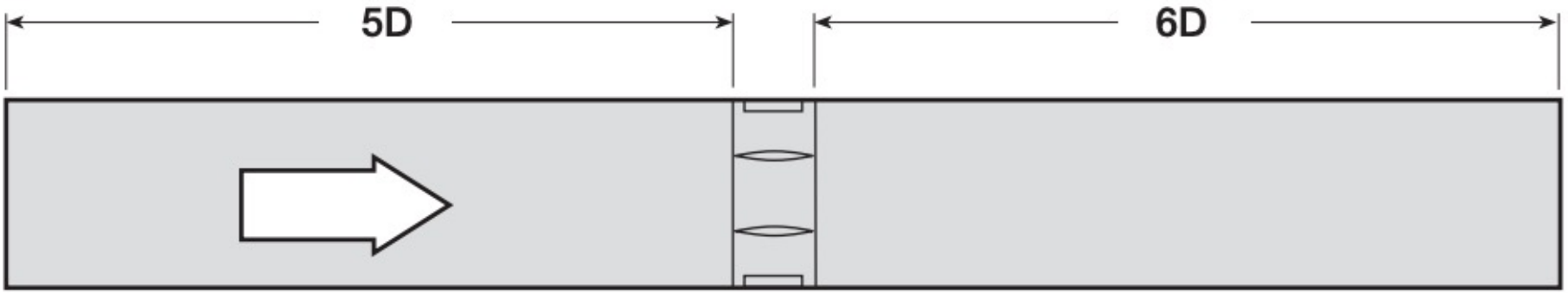


Figure 5.3

https://content.greenheck.com/public/DAMProd/Original/10002/ControlDampers_catalog.pdf

Sizing Dampers

- How to calculate the pressure drop using manufacture datasheets:
  - ❑ Ducted damper exhausting air into an open area:

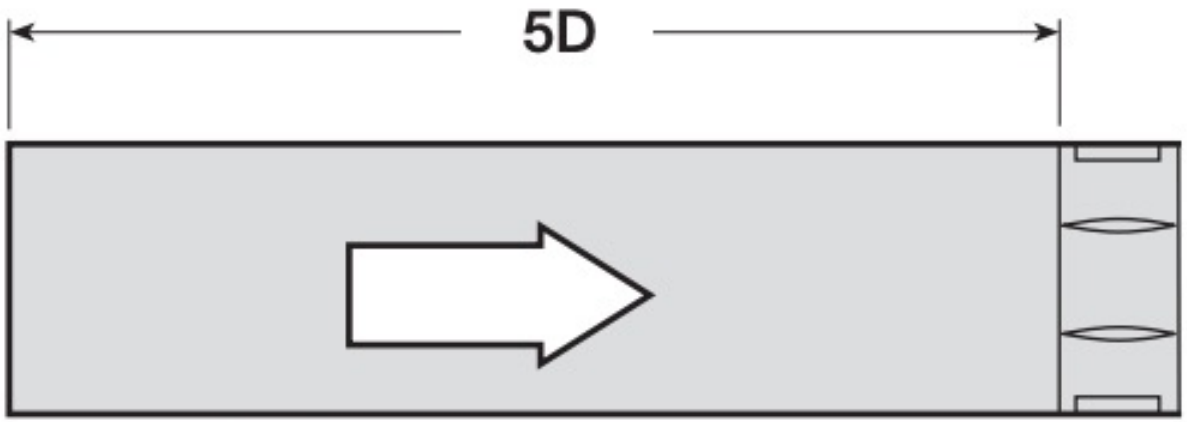


Figure 5.2

https://content.greenheck.com/public/DAMProd/Original/10002/ControlDampers_catalog.pdf

Sizing Dampers

- How to calculate the pressure drop using manufacture datasheets:
  - ❑ A plenum mounted damper

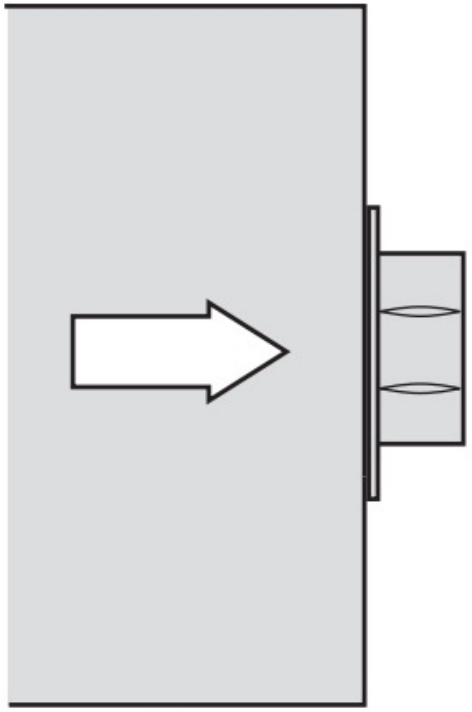


Figure 5.5

https://content.greenheck.com/public/DAMProd/Original/10002/ControlDampers_catalog.pdf

Sizing Dampers

- A few examples:

ICD-44 and ICD-45

- Extruded aluminum airfoil blades with thermal breaks and insulated with polyurethane foam
- Extruded Frame (ICD-44) with thermal breaks (ICD-45)

Dimension inches	12x12			24x24			36x36			12x48			48x12		
AMCA figure	5.2	5.3	5.5	5.2	5.3	5.5	5.2	5.3	5.5	5.2	5.3	5.5	5.2	5.3	5.5
Velocity (ft/min.)	Pressure Drop in. wg														
500	.03	.01	.05	.02	.01	.05	.01	.01	.04	.01	.01	.04	.03	.01	.05
1000	.11	.04	.23	.08	.03	.21	.05	.02	.14	.06	.02	.18	.14	.06	.22
1500	.25	.09	.52	.19	.08	.47	.11	.04	.33	.14	.06	.42	.32	.14	.51
2000	.45	.17	.93	.34	.14	.84	.21	.08	.58	.25	.10	.74	.57	.25	.90
2500	.71	.26	1.44	.53	.22	1.32	.33	.12	.91	.40	.17	1.16	.89	.40	1.41
3000	1.03	.38	2.08	.77	.32	1.90	.47	.18	1.31	.57	.24	1.68	1.29	.58	2.04
3500	1.40	.52	2.83	1.05	.43	2.59	.64	.24	1.79	.78	.33	2.28	1.76	.79	2.78
4000	1.83	.67	3.70	1.37	.57	3.39	.84	.32	2.34	1.02	.43	2.98	2.30	1.03	3.70

https://content.greenheck.com/public/DAMProd/Original/10002/ControlDampers_catalog.pdf

Sizing Dampers

- More examples are available here:

FINAL REPORT

FLOW RESISTANCE AND MODULATING CHARACTERISTICS OF CONTROL DAMPERS (RP-1157)

Sponsoring Technical Committees:

TC 5.2, Duct Design
TC 1.4, Control Theory and Application

CLASS ACTIVITY

Class Activity

- Some vendors

Honeywell | Building Controls

NEWS | VIDEOS | CONTACT Search

CONTRACTOR LOCATOR | PRODUCTS | CASE STUDIES | ENGINEERING SPECS

Home > Dampers, Actuators & Valves > Dampers

Rectangular Dampers

Built stronger to last longer.

- Feature heavy-duty airfoil an hat channel frames for dependable operation inside ductwork.
- Low-profile top and bottom frames
- Airfoil blades (D1 dampers) or 3-V style blades (D2 and D3 dampers)
- Galvanized, stainless or aluminum material
- 12, 14 or 16 gauge
- Vinyl or silcone blade seals
- Synthetic, bronze or stainless bearings
- Steel or stainless axles and linkages
- Single, double, reverse or no flange
- Rectangular Dampers
- Simplify quoting this product with CPQ Select

Round Dampers

Tight close off and low leakage

- 6" to 16" round dampers used in zoning systems
- Neoprene seal for tight closing and low leakage
- Oilite bearings for long life
- 90° damper travel for a variety of applications
- Available without actuator (DM690) or with factory mounted actuator for simple field installation (DM7600)
- Maximum approach velocity 2,500 ft/min
- Temperature range 32°F to 130°F(0°C to 54°C)
- Round Dampers
- Simplify quoting this product with CPQ Select

Airflow Measuring Stations (AMS)

Accurately measure airflow within a duct

- Allows you to control the amount of outside air coming into the building
- Meets minimum outdoor air requirements of ASHRAE Standard 62 or California Title 24
- Features include a sleeve, honeycomb air straightener, pick up tubes, pressure transducer, and optional controller
- Single sections up to 60" x 48"
- AMD-23, AMD-33, AMD-42 models are AMS factory installed into a D1, D2 or VCD-42 damper and a standard modulating actuator
- Product Resources for Airflow Measuring Stations (AMS)
- Simplify quoting this product with CPQ Select

https://buildingcontrols.honeywell.com/subcategory/Dampers-Actuators-Valves/Dampers

Class Activity

- Some vendors

RUSKIN
AUTHORITY IN AIR CONTROL

Ruskin® Quick Product Selection Tables: Commercial Dampers

The Quick Product Selection Reference Guide assists in selecting the appropriate _Ruskin_® Product for your application.

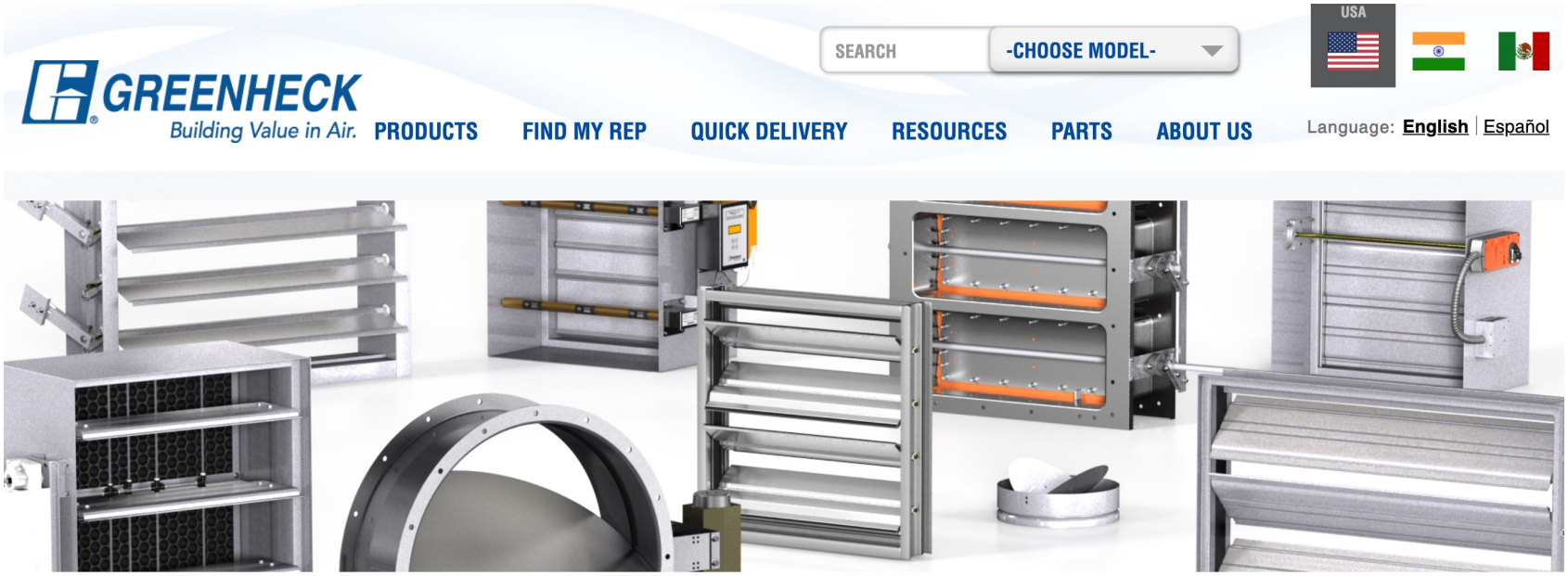
Commercial Airfoil Blades

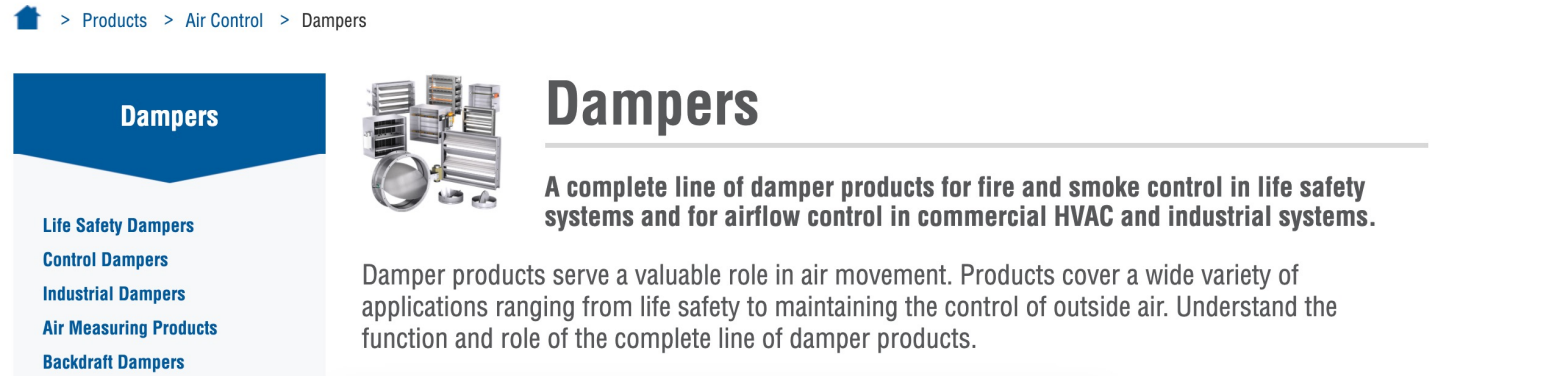
Commercial V Groove Blades

https://www.ruskin.com/doc/Id/6959

Class Activity

- Some vendors





https://www.greenheck.com/products/air-control/dampers

Class Activity

- Some vendors

https://www.johnsoncontrols.com/hvac-equipment/air-distribution/dampers-and-louvers

Class Activity

- Form your groups

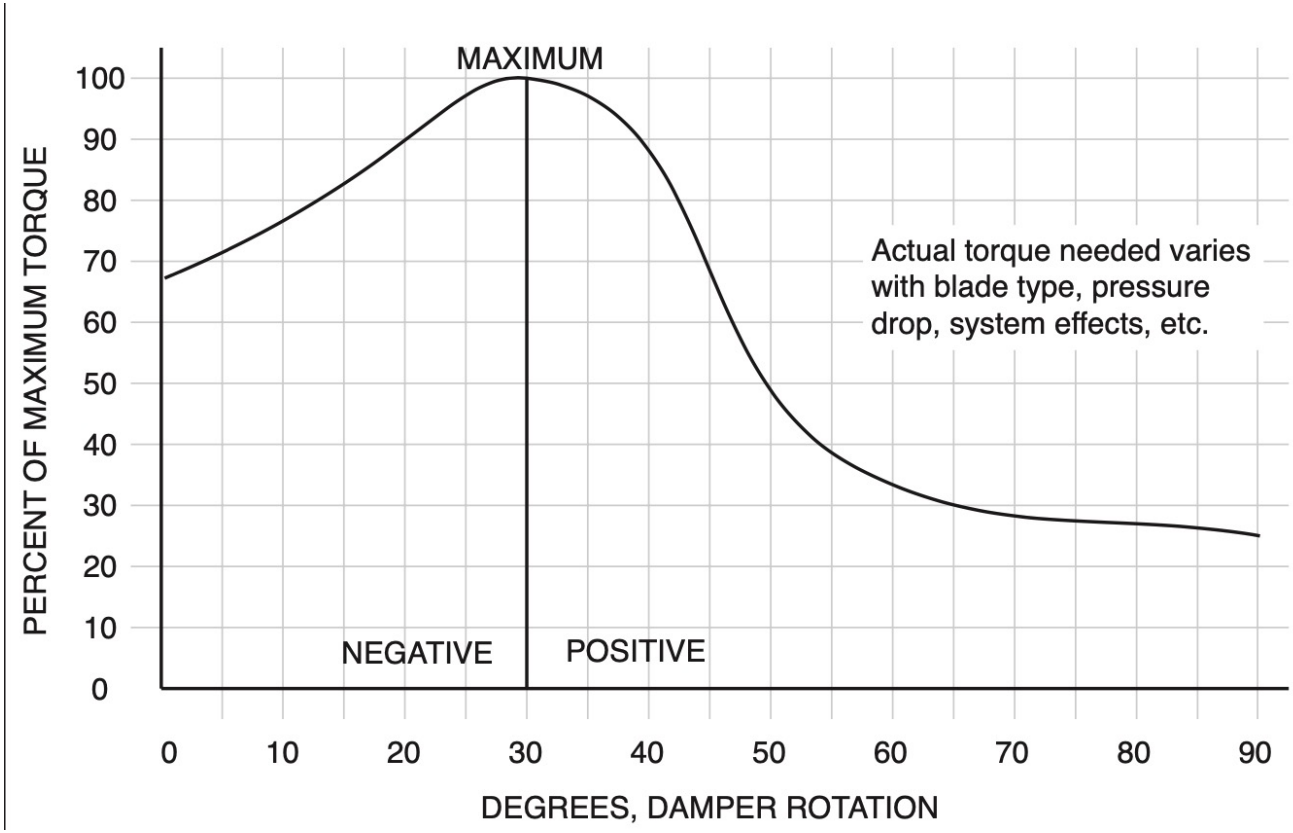
- Fill in the spreadsheet (at 3 different vendors, two rectangular and two circular damper; two different sizes consider with at least of them being sized for 12” x 12”)

https://docs.google.com/spreadsheets/d/1duxKfuy1kpYNJxXT6e9bHjVBBqUXnwBSBuR8Dkz4f7c/edit#gid=2027297225

ACTUATORS

Actuators

- Torque is an important factor since:
  - ❑ It is required to operate a damper
  - ❑ It depends on the size, type, quality, and condition of the damper, differential pressure and airflow



Actuators

- There are different control action strategies:
  - ❑ Two position (e.g., on / off)
  - ❑ Floating (e.g., three position on / stop / off)
  - ❑ Proportional
  - ❑ Modulating a continuous range (e.g., 0 to 100% open)

Actuators

Manual
Quadrant

Electric
External Mount

Electric
Internal Mount

Pneumatic

https://content.greenheck.com/public/DAMProd/Original/10002/ControlDampers_catalog.pdf

Actuators

- Pneumatic actuators:

https://content.greenheck.com/public/DAMProd/Original/10002/ControlDampers_catalog.pdf

DAMPER LEAKAGE

Dampers

- Damper leakage classes are:

Allowable Air Leakage to Achieve Classification

SI	Maximum Allowable Leakage, L/s/m^2		
Class	at 0.25 kPa[1]	at 1.0 kPa[1]	at *x* kPa[2]
1A	15.2	N/A	N/A
1	20	41	$2\sqrt{x} \times 20$
2	51	102	$2\sqrt{x} \times 51$
3	203	406	$2\sqrt{x} \times 203$

I-P	Maximum Allowable Leakage, cfm/ft^2		
Class	at 1 in. wg[1]	at 4 in. wg[1]	at *x* in. wg[2]
1A	3	N/A	N/A
1	4	8	$\sqrt{x} \times 4$
2	10	20	$\sqrt{x} \times 10$
3	40	80	$\sqrt{x} \times 40$

Notes:
[1] Required pressures; shall be cataloged
[2] Any other pressure may be cataloged using these formulas

https://www.amca.org/assets/resources/public/userfiles/file/CRP%20Publications/amca_511-13.pdf

Dampers

- Damper leakage classes are:

Chart 1: Leakage Classifications per AMCA Standard 511

Pressure/ Class	Leakage, cfm/ft² (L/S/m²)			
	Required Rating		Extended Ranges (Optional)	
	1″ w.g. (0.25kPA)	4″ w.g. (1.0kPA)	8″ w.g. (2.0kPA)	12″ w.g. (3.0kPA)
1A	3 (15.2)	8 (40.6)	11 (55.9)	14 (71.1)
1	4 (20.3)	8 (40.6)	11 (55.9)	14 (71.1)
2	10 (50.8)	20 (102)	28 (142)	35 (178)
3	40 (203)	80 (406)	112 (569)	140 (711)

Chart 2: UL555S Classified Leakage Ratings

Leakage Class	Leakage, cfm/ft² (L/S/m²)		
	4″ w.g. (1.0kPA)	8″ w.g. (2.0kPA)	12″ w.g. (3.0kPA)
I	8 (40.6)	11 (55.9)	14 (71.1)
II	20 (102)	28 (142)	35 (178)
III	80 (406)	112 (569)	140 (711)

https://www.ruskin.com/doc/id/3149

Dampers

- Damper leakage requirements per ASHRAE 90.1 2019

Table 6.4.3.4.3 Maximum Damper Leakage[a,b], cfm per ft^2 at 1.0 in. of water

Climate Zone	Outdoor Air Intake		Exhaust/Relief	
	Nonmotorized[a]	Motorized	Nonmotorized[c]	Motorized
0, 1, 2				
Any height	20	4	20	4
3				
Any height	20	10	20	10
4, 5B, 5C				
Fewer than three stories	20[d]	10	20	10
Three or more stories	20[d]	10	20[d]	10
5A, 6, 7, 8				
Fewer than three stories	20[d]	4	20	4
Three or more stories	20[d]	4	20[d]	4

a. When tested in accordance with AMCA Standard 500-D.
b. Dampers smaller than 12 in. in height, width, or diameter need not be tested but shall be of the same design and construction as the smallest tested damper meeting the listed leakage rate requirement.
c. Nonmotorized dampers smaller than 24 in. in height, width, or diameter may have a leakage rate of 40 cfm/ft^2.
d. Where allowed by Section 6.4.3.4.2, Exception 2.

Should we consider any other standards?

https://ashrae.iwrapper.com/ASHRAE_PREVIEW_ONLY_STANDARDS/STD_90.1_2019

Class Activity

- Form your groups

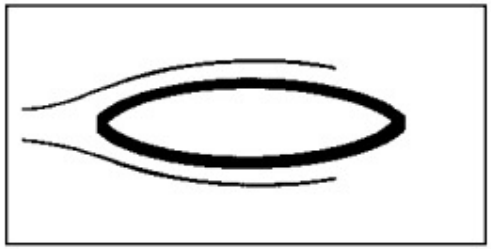
- Add the leakage category and leakage rate as well as actuator options to the list:

https://docs.google.com/spreadsheets/d/1duxKfuy1kpYNJxXT6e9bHjVBBqUXnwBSBuR8Dkz4f7c/edit#gid=2027297225

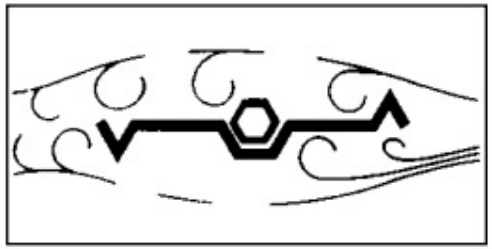
DAMPER BLADES

Damper Blades

- Common damper blade types are:
  - ❑ Airfoil
  - ❑ Triple V-Groove



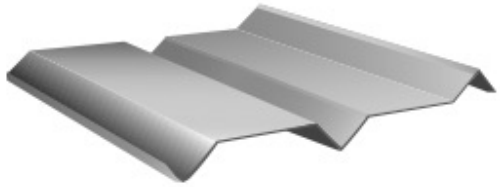
AIRFOIL



TRIPLE-V-GROOVE

Aluminum Airfoil Blade

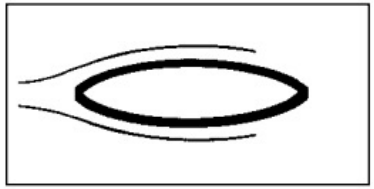
Steel Airfoil Blade



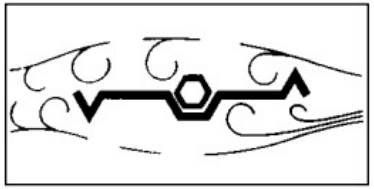
https://www.ruskin.com/doc/ld/1247 and Commercial HVAC Components
HVAC Control & Balancing Dampers

Damper Blades

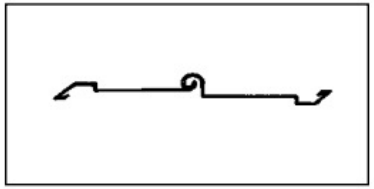
- What's the difference between these blades:



AIRFOIL



TRIPLE-V-GROOVE



MODIFIED SINGLE SKIN
(Prefco)

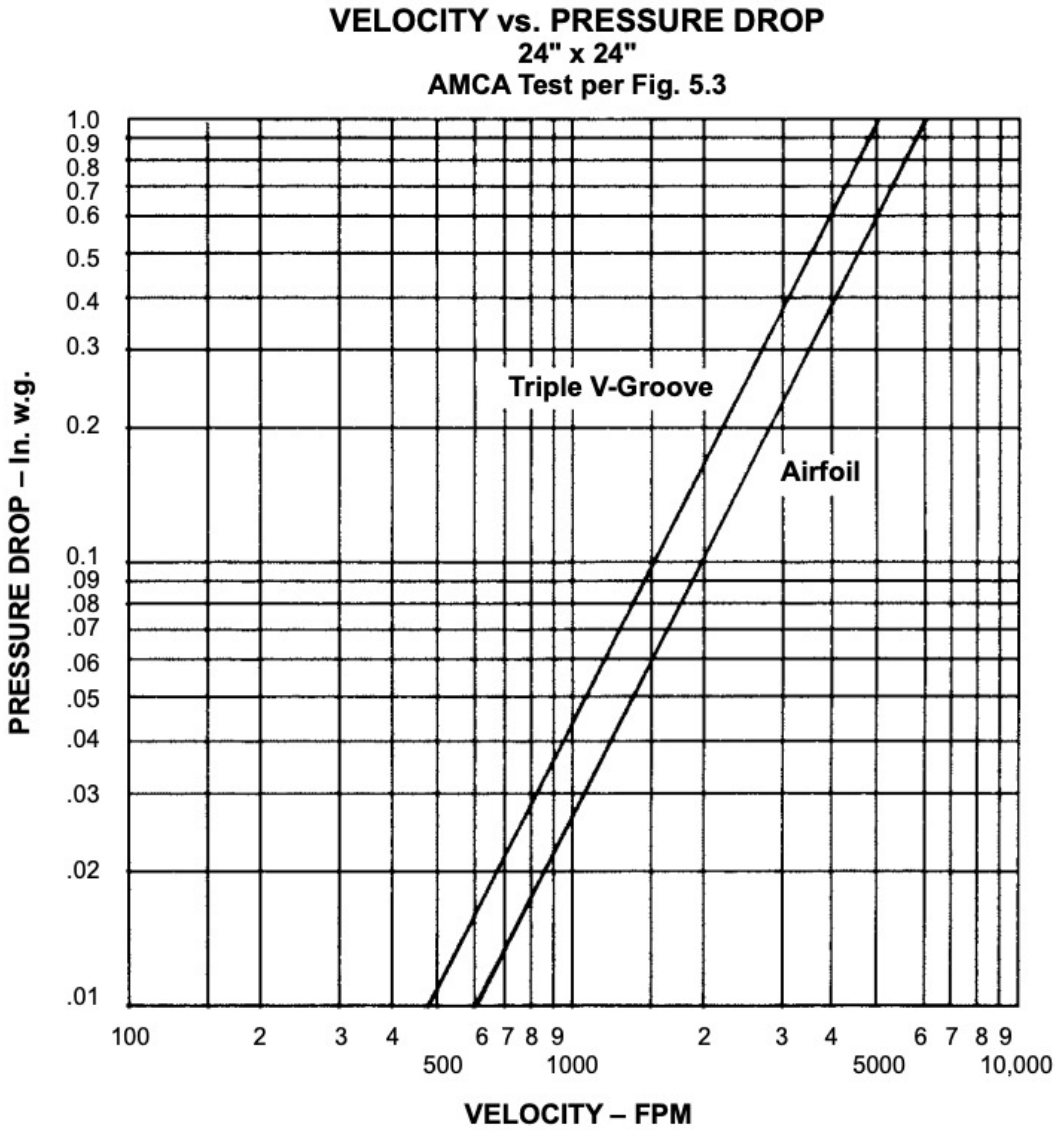
MAXIMUM INSTANTANEOUS STATIC PRESSURE*

Blade Length	Maximum Instantaneous Static Pressure – in. w.g.*		
	60 Blade Airfoil	35 Blade Triple-V-Groove 16 Gage	Modified Single Skin Prefco 20 gage
36"	17	8.5	2.1
32"	25	12.5	2.9
30"	30	15.0	3.6

https://www.ruskin.com/doc/Id/1247

Damper Blades

- What's the difference between these blades:



https://www.ruskin.com/doc/Id/1247

Damper Blades

- What's the difference between these blades:

NOISE CRITERIA

Velocity	Airfoil	Triple-V-Groove	Prefco Single Skin
1000 FPM	19 NC	30 NC	29 NC
2000 FPM	35 NC	46 NC	46 NC
3000 FPM	45 NC	55 NC	58 NC
4000 FPM	51 NC	60 NC	63 NC

1. NC based on noise generated in third octave band with 10 db room attenuation.
2. Test conducted in accordance with ASTM Standard E477-80.

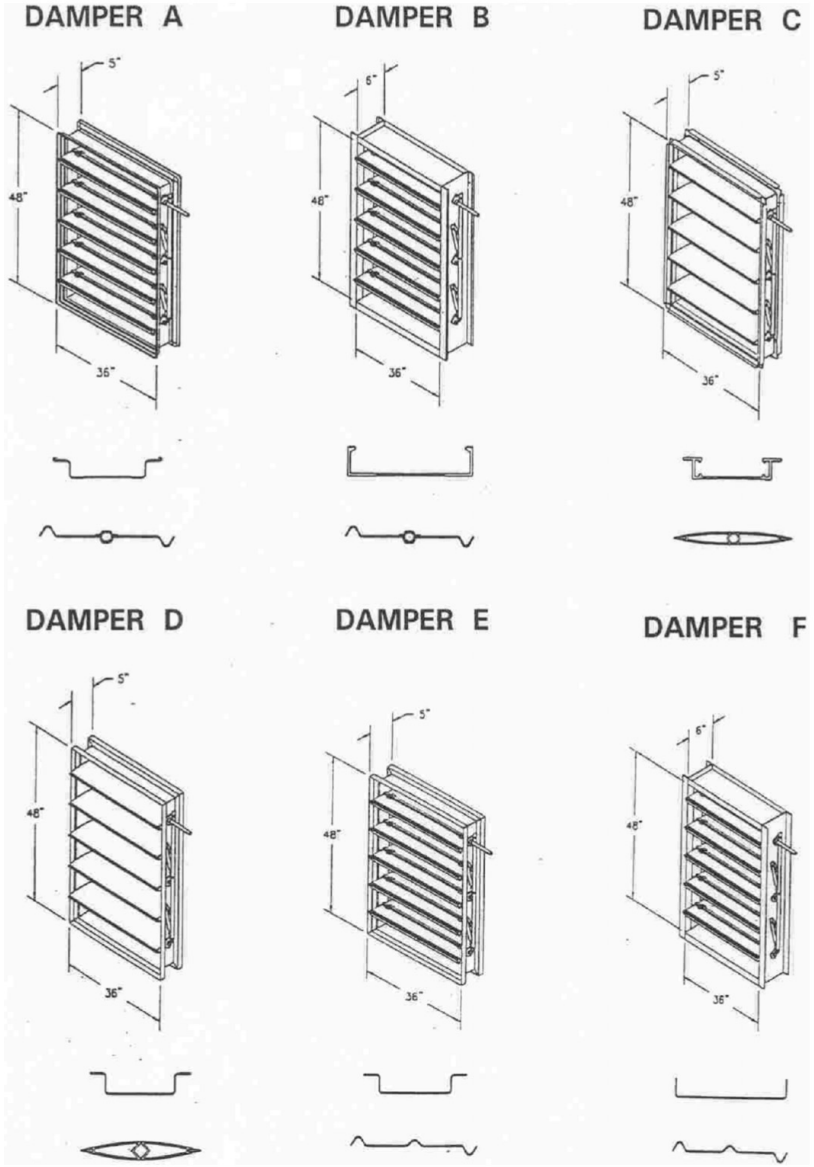
https://www.ruskin.com/doc/Id/1247

Damper Blades

- Some examples:

Damper	Size	Blade Action	Blade Type	Frame	% Free Area
A	36"× 48"	OB	3V	5×1 hat channel	80
A	36"× 48"	PB	3V	5×1 hat channel	80
B	36"× 48"	OB	3V	6×1 flange frame	90
B	36"× 48"	PB	3V	6×1 flange frame	90
C	36"× 48"	OB	AF	5×1 hat channel	80
C	36"× 48"	PB	AF	5×1 hat channel	80
D	36"× 48"	PB	AF	5×1 hat channel	80
D	36"× 48"	OB	AF	5×1 hat channel	80
E	36"× 48"	OB	3V	5×1 hat channel	80
E	36"× 48"	PB	3V	5×1 hat channel	80
F	36"× 48"	OB	3V	6×1 flange frame	90
F	36"× 48"	PB	3V	6×1 flange frame	90

Note:
Dampers A, B, and C are manufactured by one manufacturer.
Dampers D, E, and F are manufactured by another manufacturer.
Louver: 36" × 48", 6" deep louver with 54% free area.



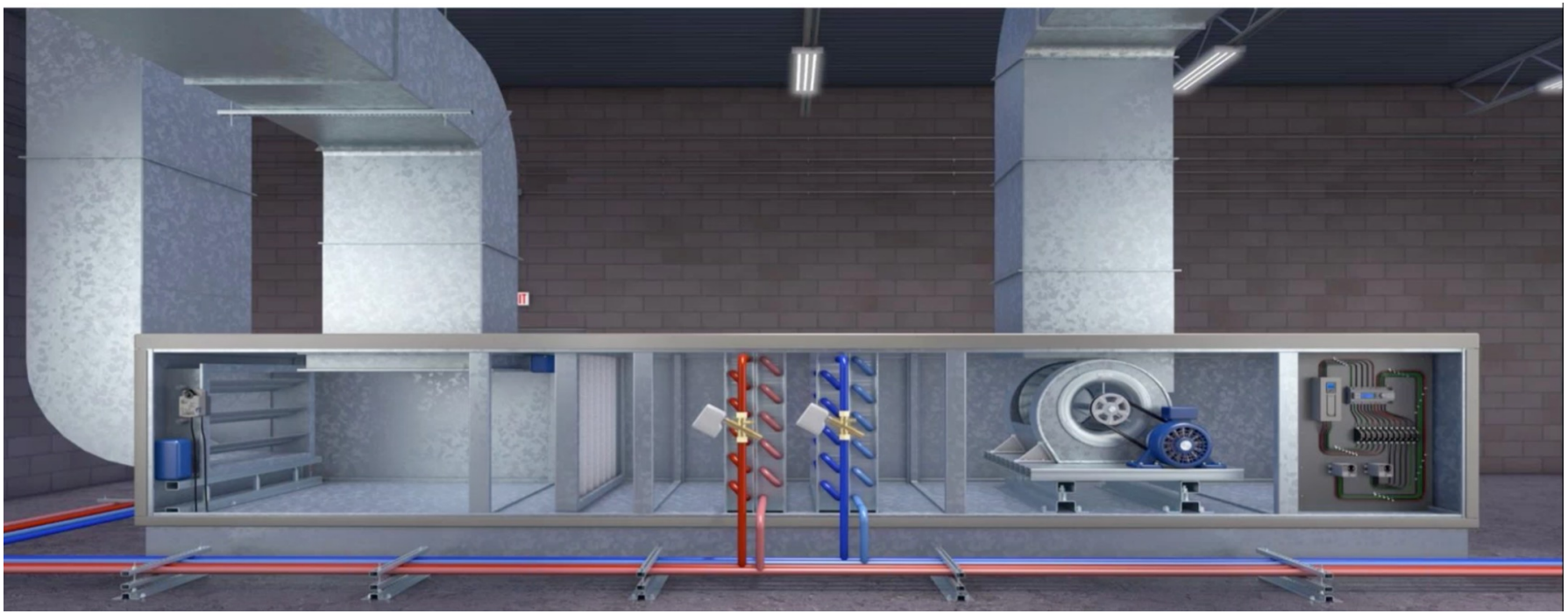
Van Becelaere et al. (2005), ASHRAE

INTRO TO VALVES

Intro to Valves

- Valves are important controlled devices in hydronic systems since they control:
  - ❑ Heat transfer
  - ❑ Flow rates

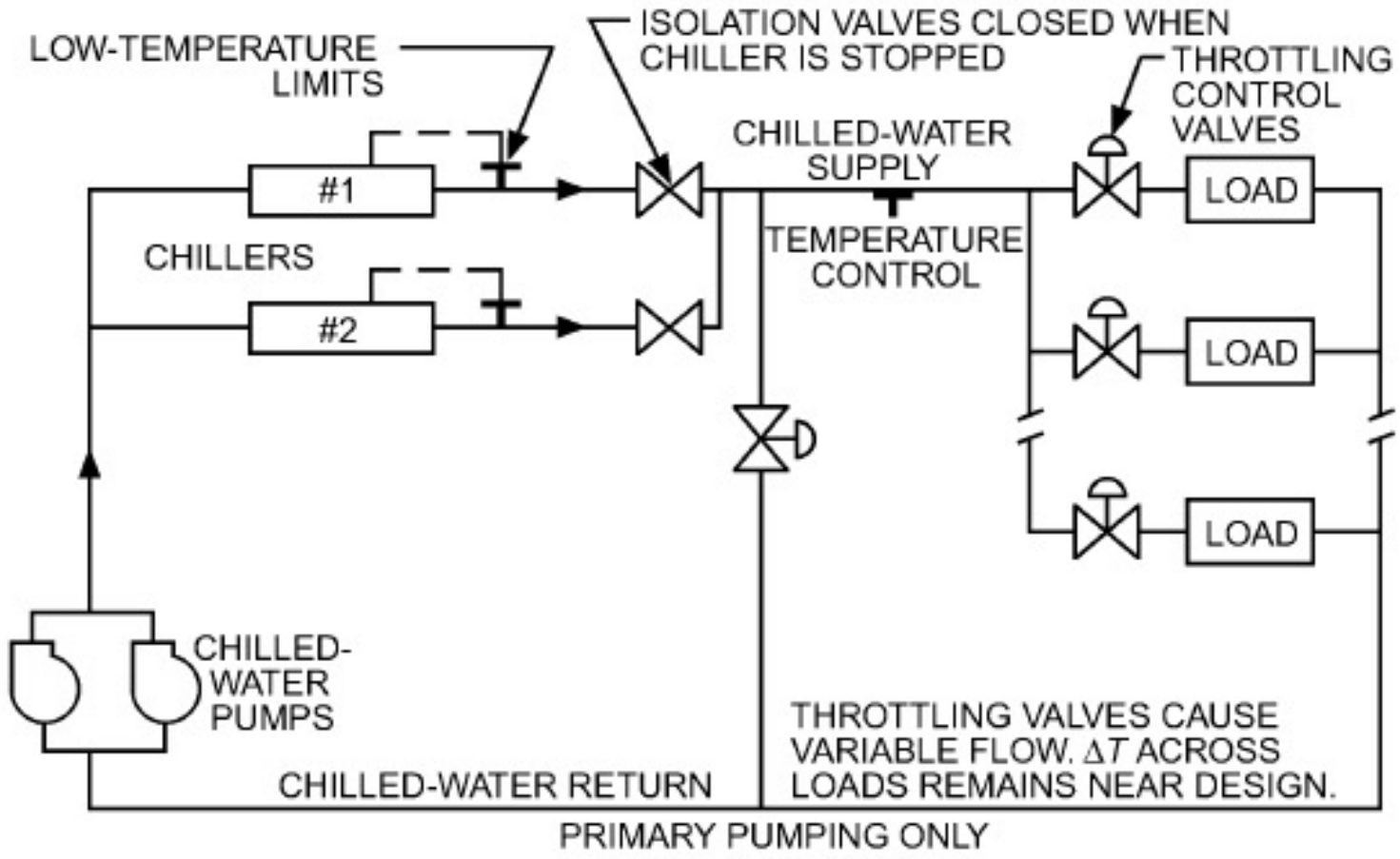
$$q = 500 \times GPM \times \Delta T$$



Credit: Siemens

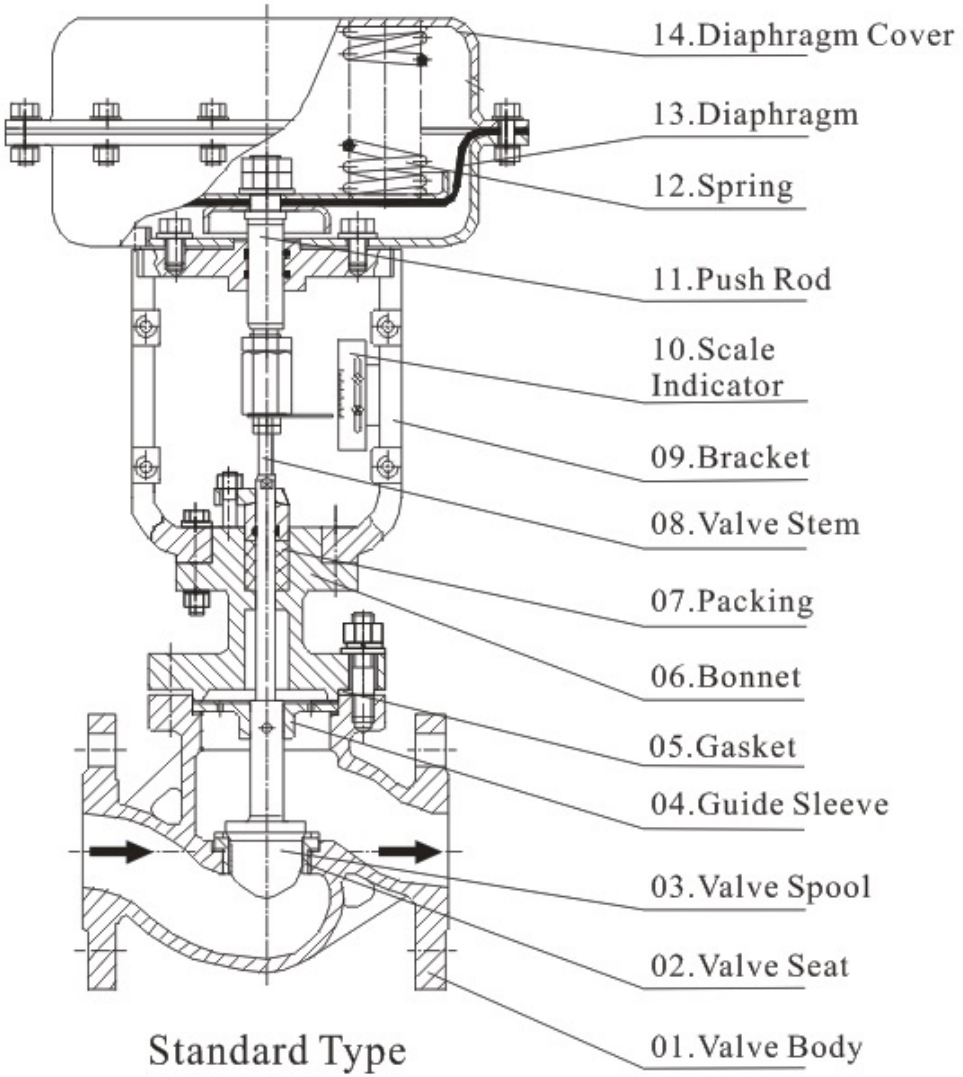
Intro to Valves

- Another example of a valve installation is in variable flow chilled water system.



Intro to Valves

- Valve includes different components:



https://www.shautovalve.com/pneumatic-control-valve/hts-single-seat-pneumatic-control-valve

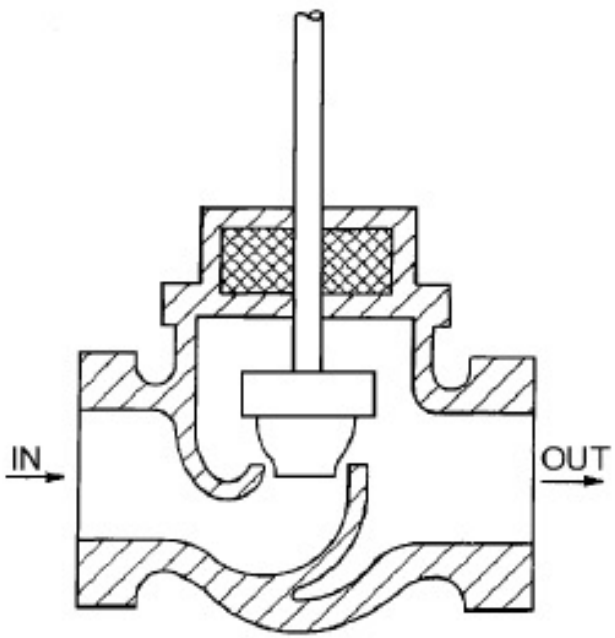
Intro to Valves

- Valves have different configurations:
  - Single-seated valve
  - Double-seated or balanced valve
  - Three-way mixing valve
  - Three-way diverting valve

Intro to Valves

- Single-seated valves are:

  - ❑ Advantages:
    - ❖ Simple design
    - ❖ Simplified maintenance
    - ❖ Smaller and lighter
    - ❖ Good shut-off
  - ❑ Disadvantages:
    - ❖ It require more complex designs
    - ❖ More torque is required



A. SINGLE-SEATED

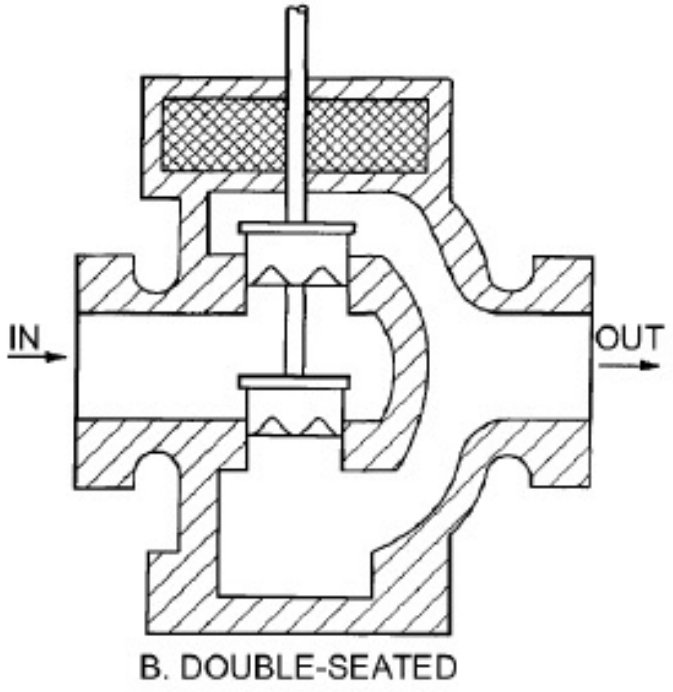
https://www.youtube.com/watch?v=pTzx2ecA7Dc

Intro to Valves

- Double-seated valves are:

  - ❑ Advantages:
    - ❖ Lower actuator force
    - ❖ Action can be easily changed
    - ❖ High flow capacity

  - ❑ Disadvantages:
    - ❖ Poor shut-off.
    - ❖ Heavy and bulky
    - ❖ More parts to service

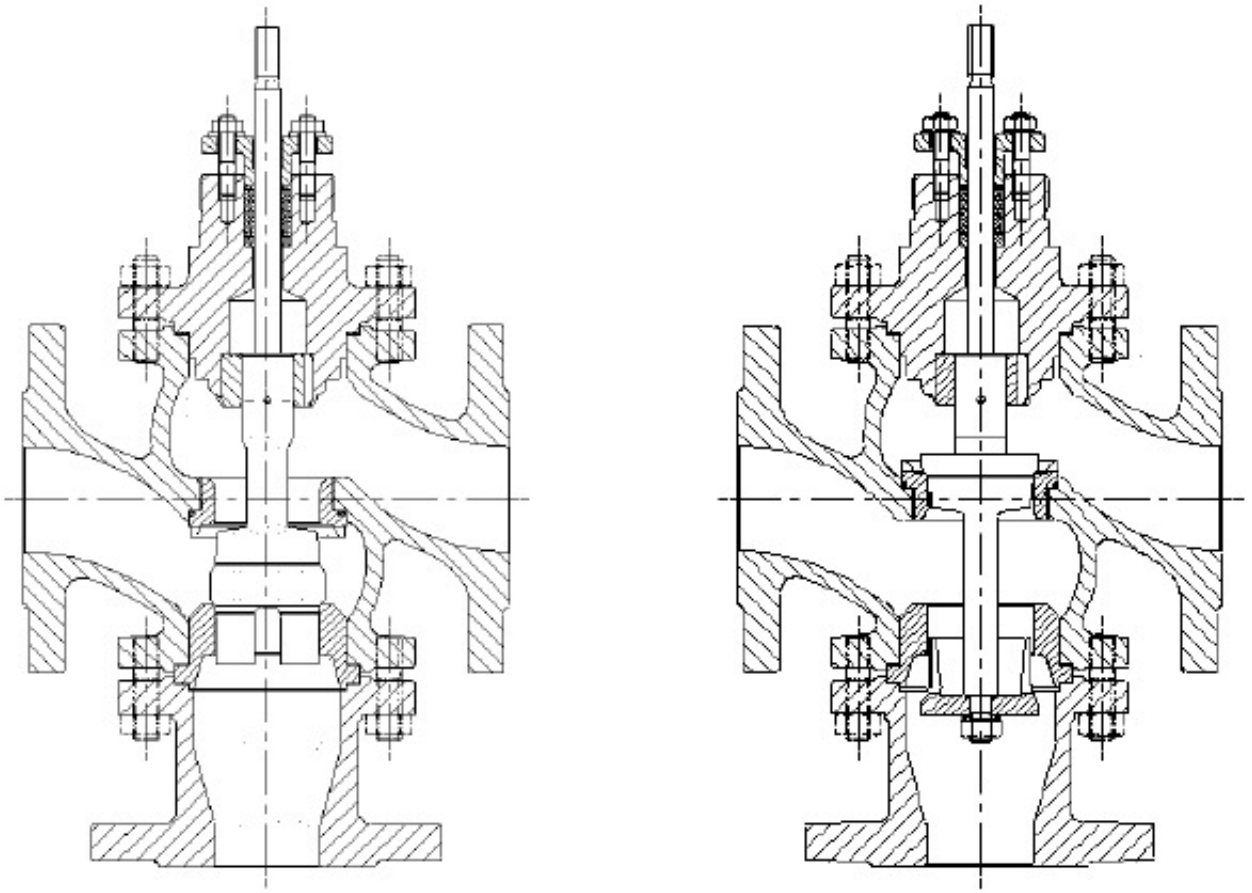


B. DOUBLE-SEATED

https://www.youtube.com/watch?v=pTzx2ecA7Dc

Valves

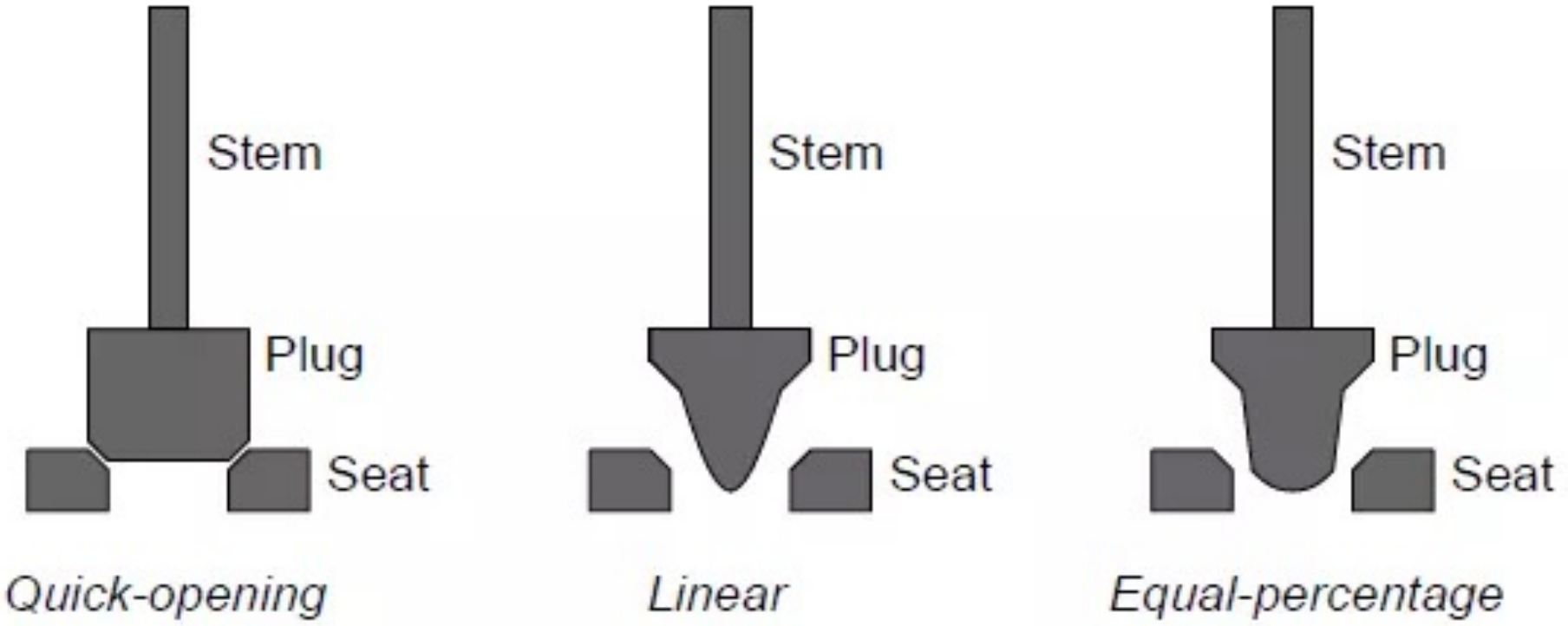
- Three-way mixing valve and three way diverting valves



https://www.youtube.com/watch?v=IefDVDsm4Wk

VALVE CHARACTERISTICS

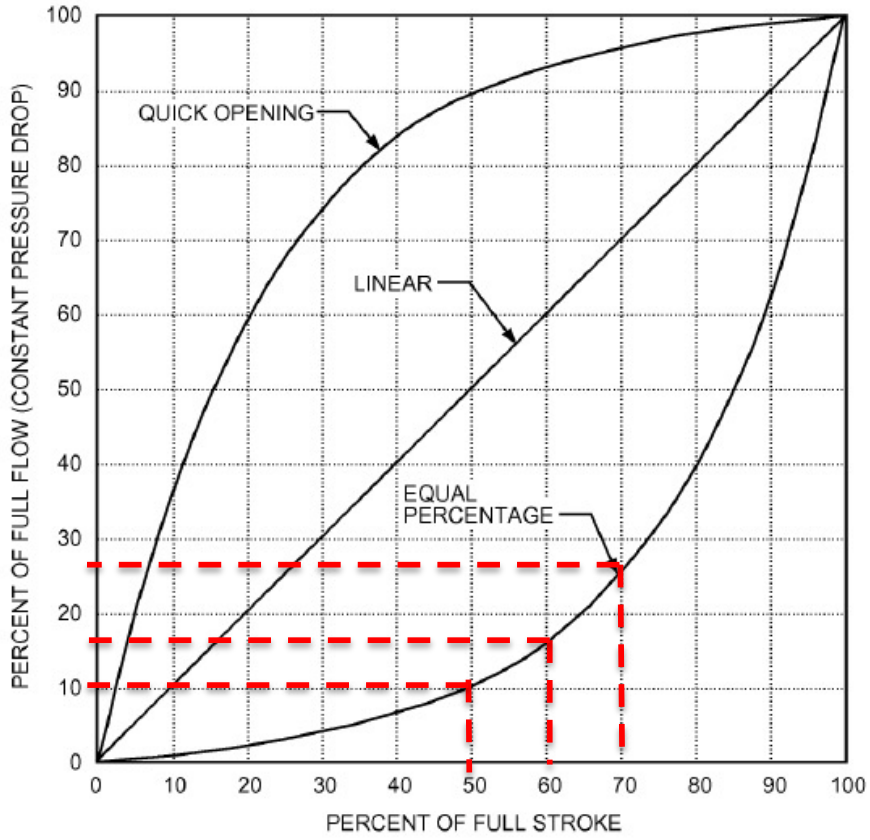
Valve Characteristics



Valve Characteristics

- Valve performance is expressed in terms of its flow characteristics. Common characteristics are:

  - **Equal Percentage:** Each equal increment of opening increases flow by an equal percentage over the previous value
  - **Quick Opening:** Maximum flow is approached as valve begins to open
  - **Linear:** Opening and flow are related in direct proportion



Valve Characteristics

- Equal Percentage valves are:
  - ❑ Primarily used in water applications
  - ❑ Used in systems with high pressure drops
  - ❑ Used in systems that small changes are allowed
  - ❑ Utilized in systems to control temperature and pressure

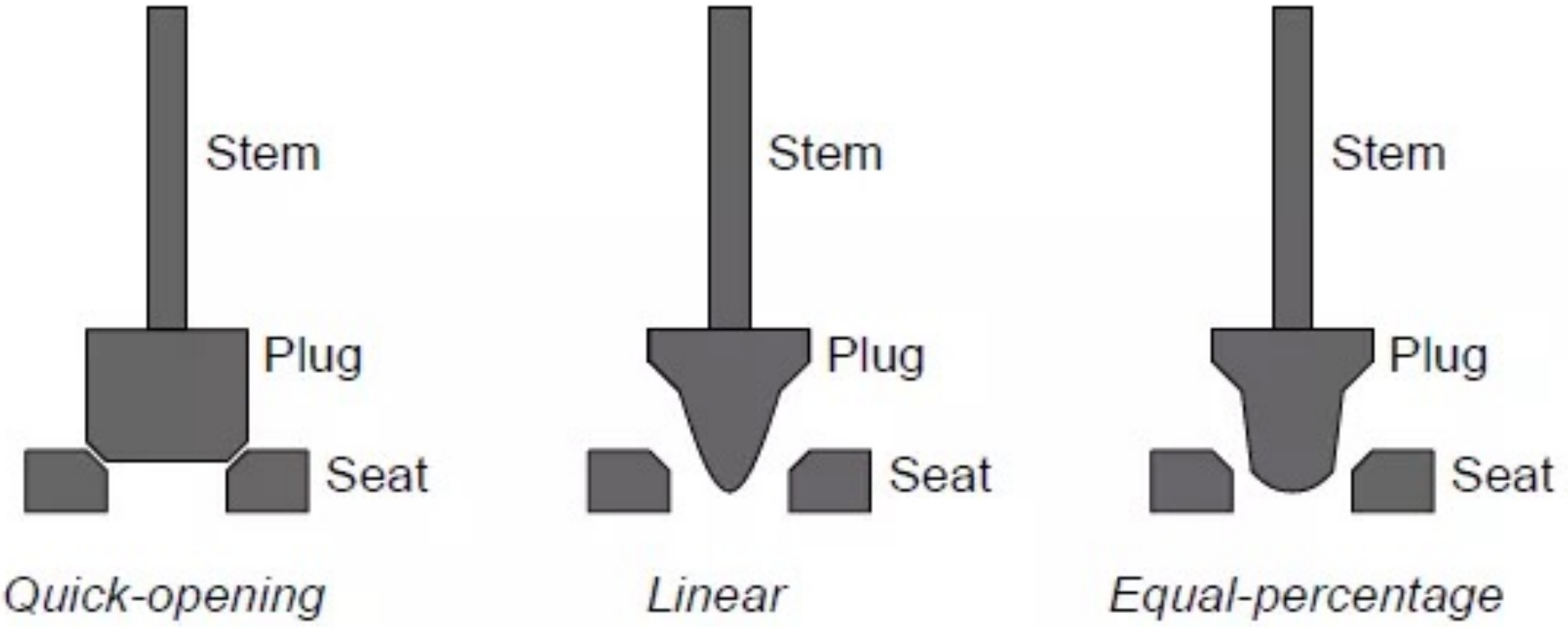
Valve Characteristics

- Linear valves are:
  - Primarily used in steam applications
  - Can be used flow loops
  - Installed in steady state systems
  - Used in systems when the valve accounts for the large portion of the pressure drop

Valve Characteristics

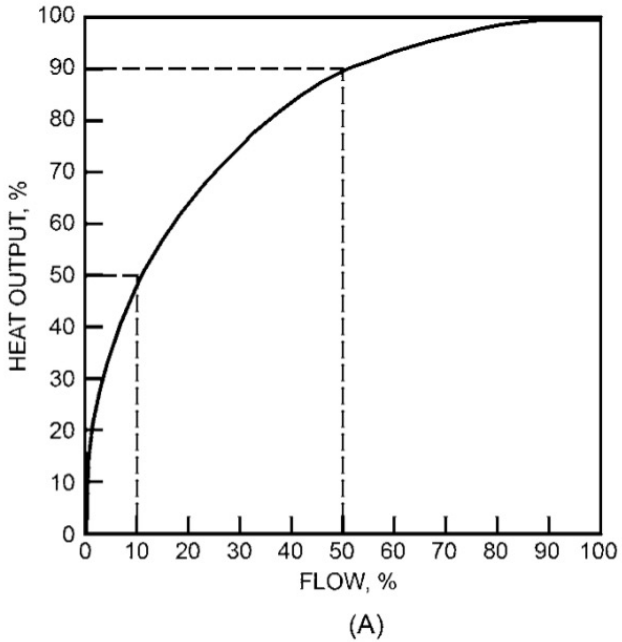
- Quick opening valves are:
  - Primarily used in on/off application
  - Used in systems where an instant large flow is required

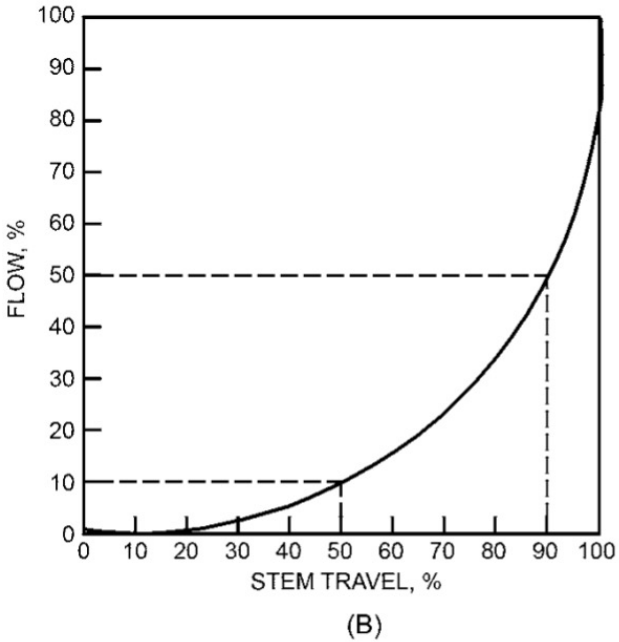
Valve Characteristics

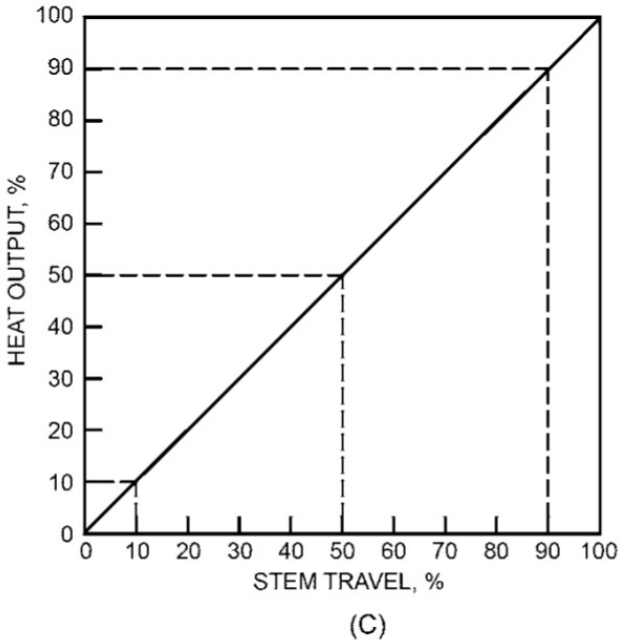


Valve Characteristics

- In a valve assembly, other components are also important in the decision-making. Why?







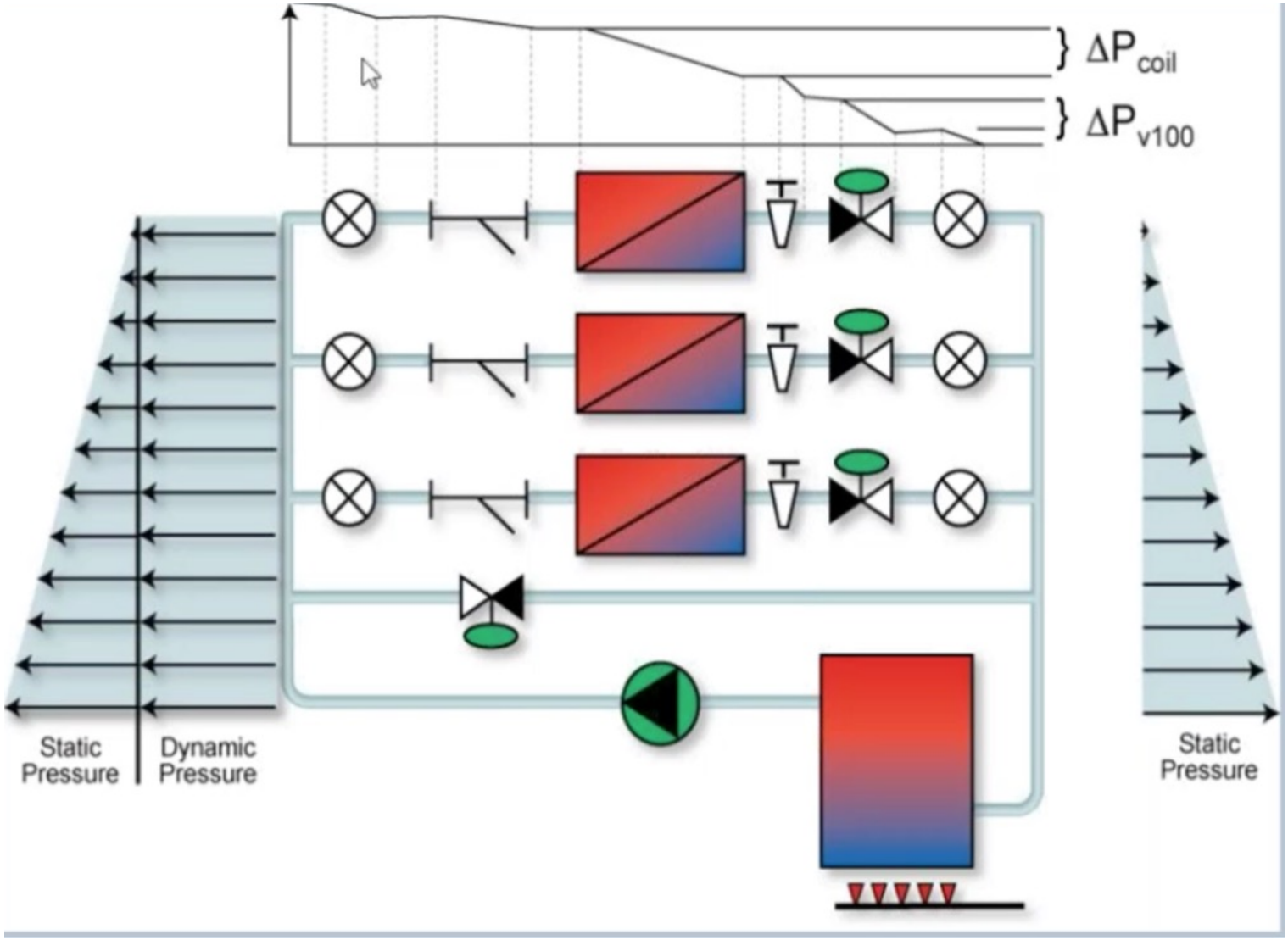
Valve Characteristics

- Valve authority is the ratio of pressure drop across control valve at maximum flow (100%) to the total total pressure drop of all components in the controlled branch as follow:

$$Valve\ Authority\ \% = \frac{Open\ Valve\ Pressure\ Drop}{Total\ System\ Pressure\ Drop} \times 100\%$$

- Try to keep it to 25% to 50%

Valve Characteristics



Credit: Siemens

Valve Characteristics

- The flow coefficient is calculated as:

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

  - SG: Specific gravity
  - C_v: Flow coefficient
  - Q: Volumetric flow rate in gpm when valve is fully open
  - ΔP: Differential pressure in psi when the valve is fully open

Why specific gravity?

Valve Characteristics

- Valves are usually sized based on the flow capacity (or flow coefficient) which varies under different coefficients

- The coefficient is:
  - C_v in IP unit
  - kvs in metric unit

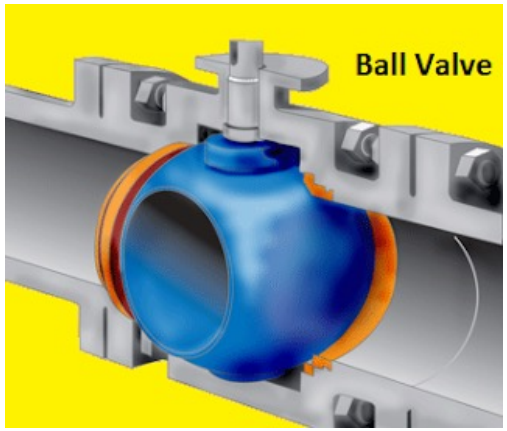
Valve Characteristics

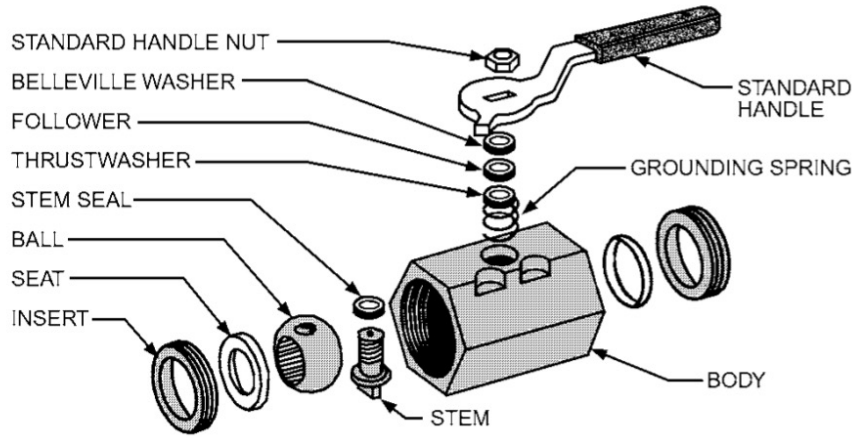
- C_v is a key factor in sizing:
  - With a too small value (undersized), the required flow rate will not be achieved even when the valve is fully opened
  - With a too large value (a high control valve), it will not provide the desired control and may cause the system

VALVE TYPES

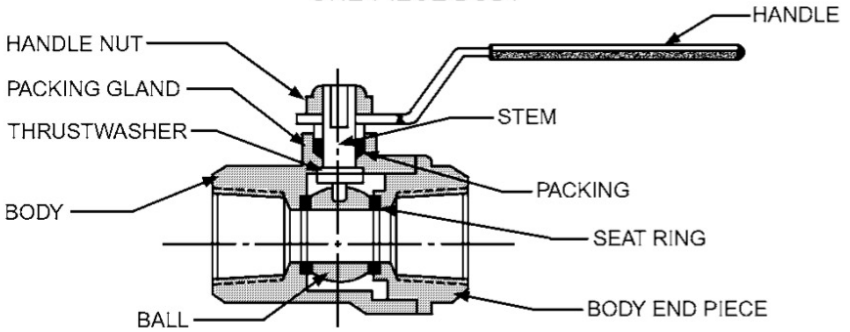
Valve Types

- Ball valves
  - ❑ There is a precision ball held between two circular seats or seals
  - ❑ It can be used for modulating applications or when full on/off is required

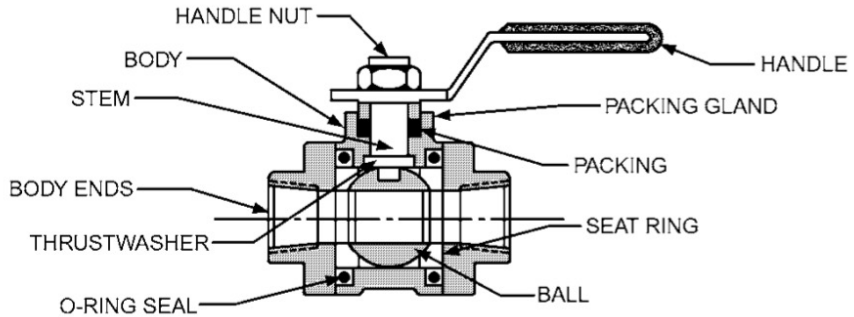




ONE-PIECE BODY



TWO-PIECE BODY



THREE-PIECE BODY

http://hvac-system-basics.blogspot.com/2012/10/ball-valve-how-it-works.html#.X2DGN5NKik4

Valve Types

- Ball valves:
  - ❑ The best control is the equal percentage
  - ❑ Offer various advantages:
    - ❖ Relatively low cost
    - ❖ High full capacity
    - ❖ Tight sealing with low torque
    - ❖ High close off pressure

  - ❑ The main disadvantage is the inherent dead bands

Credit: Siemens

Valve Types

- Butterfly valves
  - ❑ Consist of a cylindrical, flanged-end
  - ❑ The best control is linear or equal percentage
  - ❑ Mostly used for the open/closed applications
  - ❑ Throttling applications
  - ❑ Small pressure drop applications

Credit: Siemens

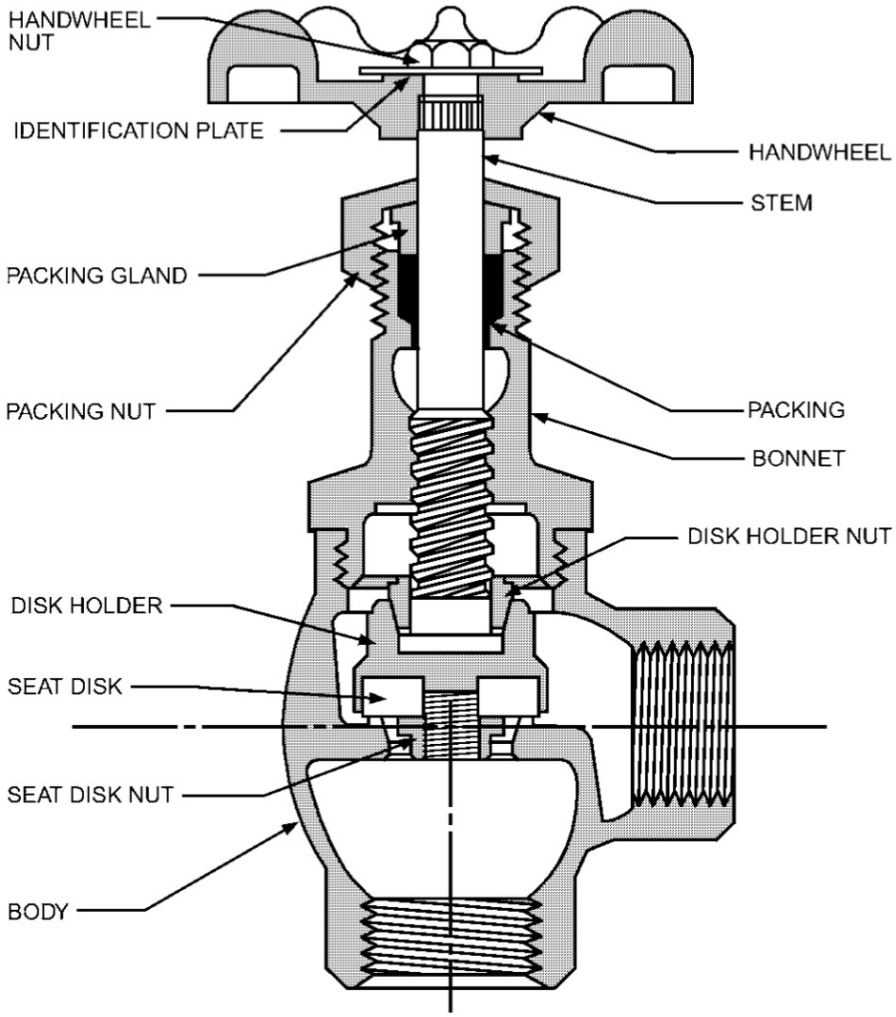
Valve Types

- Butterfly valves
  - Offer various advantages:
    - Relatively low cost
    - High full capacity
    - Low pressure drop
  - They have different disadvantages:
    - High torque requirements for control

Credit: Siemens

Valve Types

- Globe valves
  - Flow is controlled by a circular disk forced against or withdrawing form an angular ring
  - Direction of the disk movement is parallel to the flow direction
  - Mostly used in smaller pipes (up to 12”)
  - They have pressure drop when they 100% open
  - They are good for flow control not to shutoff

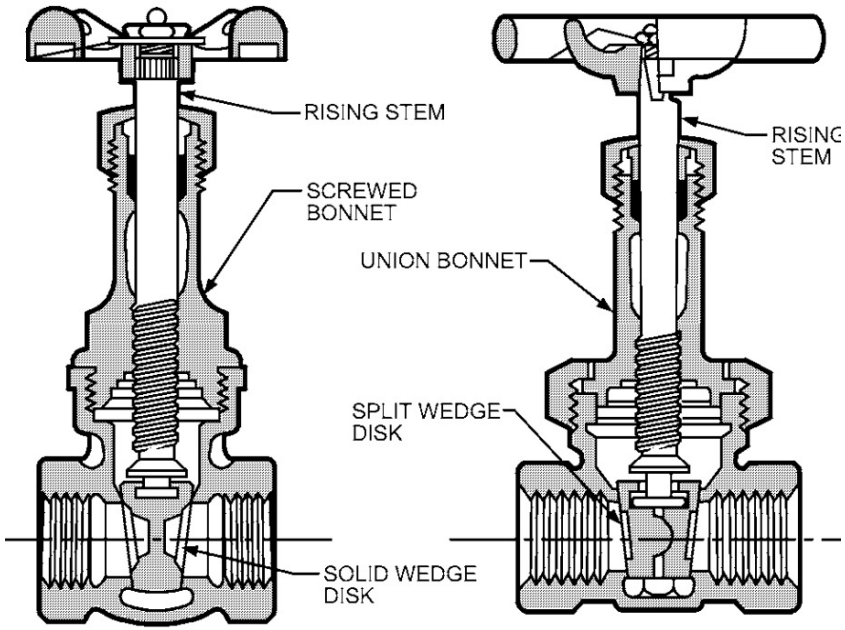


Valve Types

- Globe valves
  - The best control is the equal percentage or linear
  - Offer various advantages:
    - Suited for water and steam applications
    - Efficient and precise throttling
    - High accurate flow control
  - They have different disadvantages:
    - They have low flow coefficients
    - Relatively higher costs than other valves

Valve Types

- Gate valves
  - Flow is controlled by a wedge disk fitting against machined seating faces
  - Direction of the disk movement is perpendicular to the flow direction
  - They are either fully open or fully closed
  - They are not suitable for controlling flow

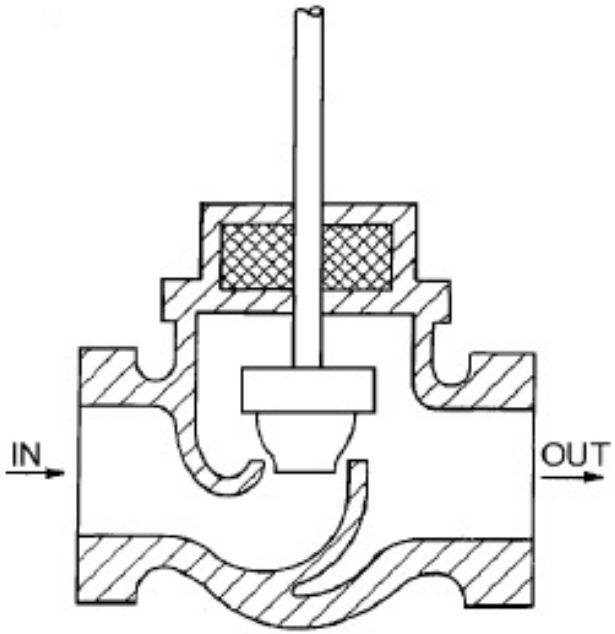


Valve Types

- Valves have different configurations:
  - Single-seated valve
  - Double-seated or balanced valve
  - Three-way mixing valve
  - Three-way diverting valve

Valve Types

- Single-seated valves are:
  - ❑ Advantages:
    - ❖ Simple design
    - ❖ Simplified maintenance
    - ❖ Smaller and lighter
    - ❖ Good shut-off
  - ❑ Disadvantages:
    - ❖ It require more complex designs
    - ❖ More torque is required

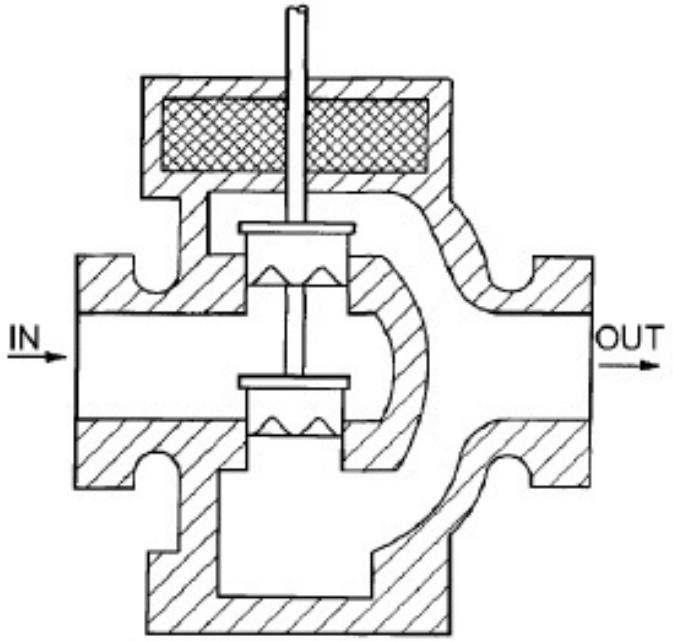


A. SINGLE-SEATED

https://www.youtube.com/watch?v=pTzx2ecA7Dc

Valve Types

- Double-seated valves are:
  - ❑ Advantages:
    - ❖ Lower actuator force
    - ❖ Action can be easily changed
    - ❖ High flow capacity
  - ❑ Disadvantages:
    - ❖ Poor shut-off.
    - ❖ Heavy and bulky
    - ❖ More parts to service

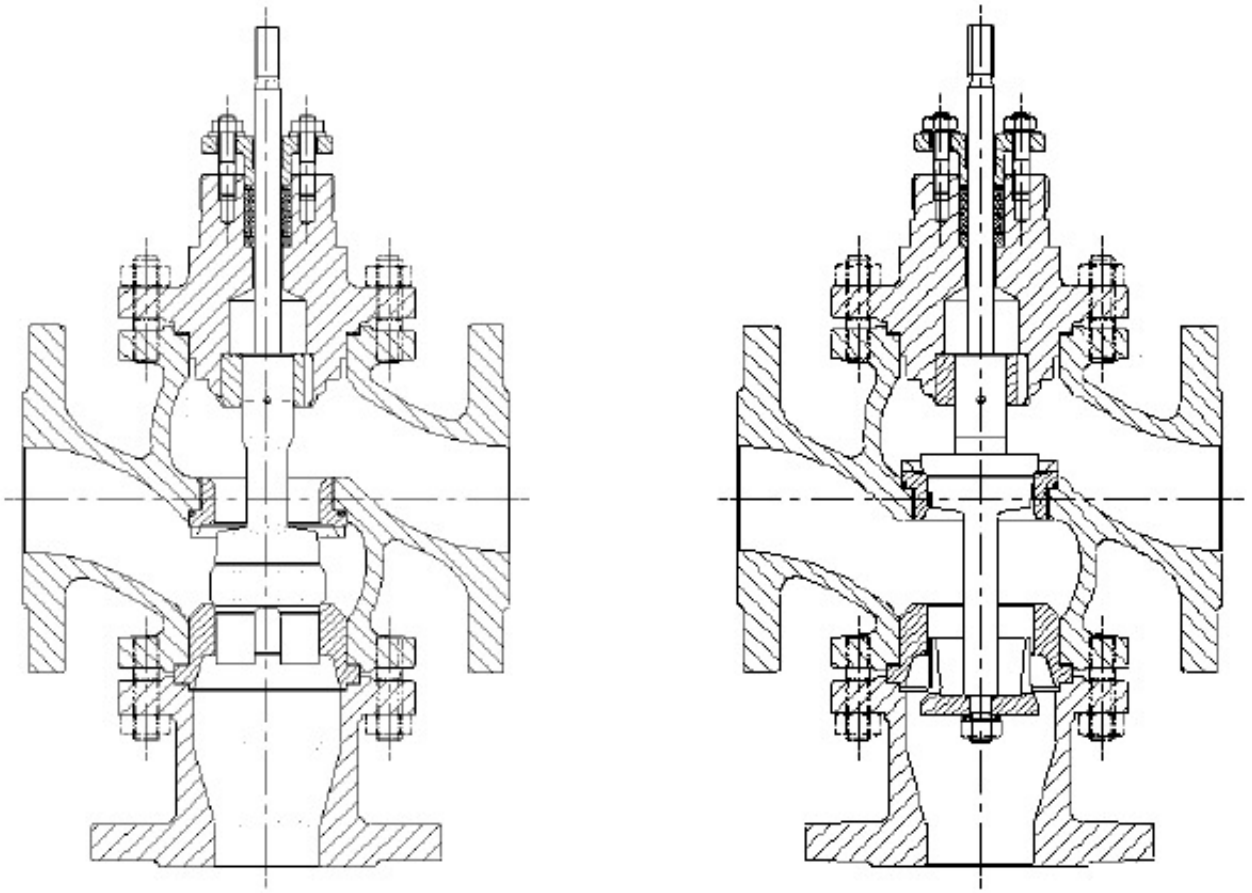


B. DOUBLE-SEATED

https://www.youtube.com/watch?v=pTzx2ecA7Dc

Valve Types

- Three-way mixing valve and three way diverting valves



https://www.youtube.com/watch?v=IefDVDsm4Wk

CLASS ACTIVITY

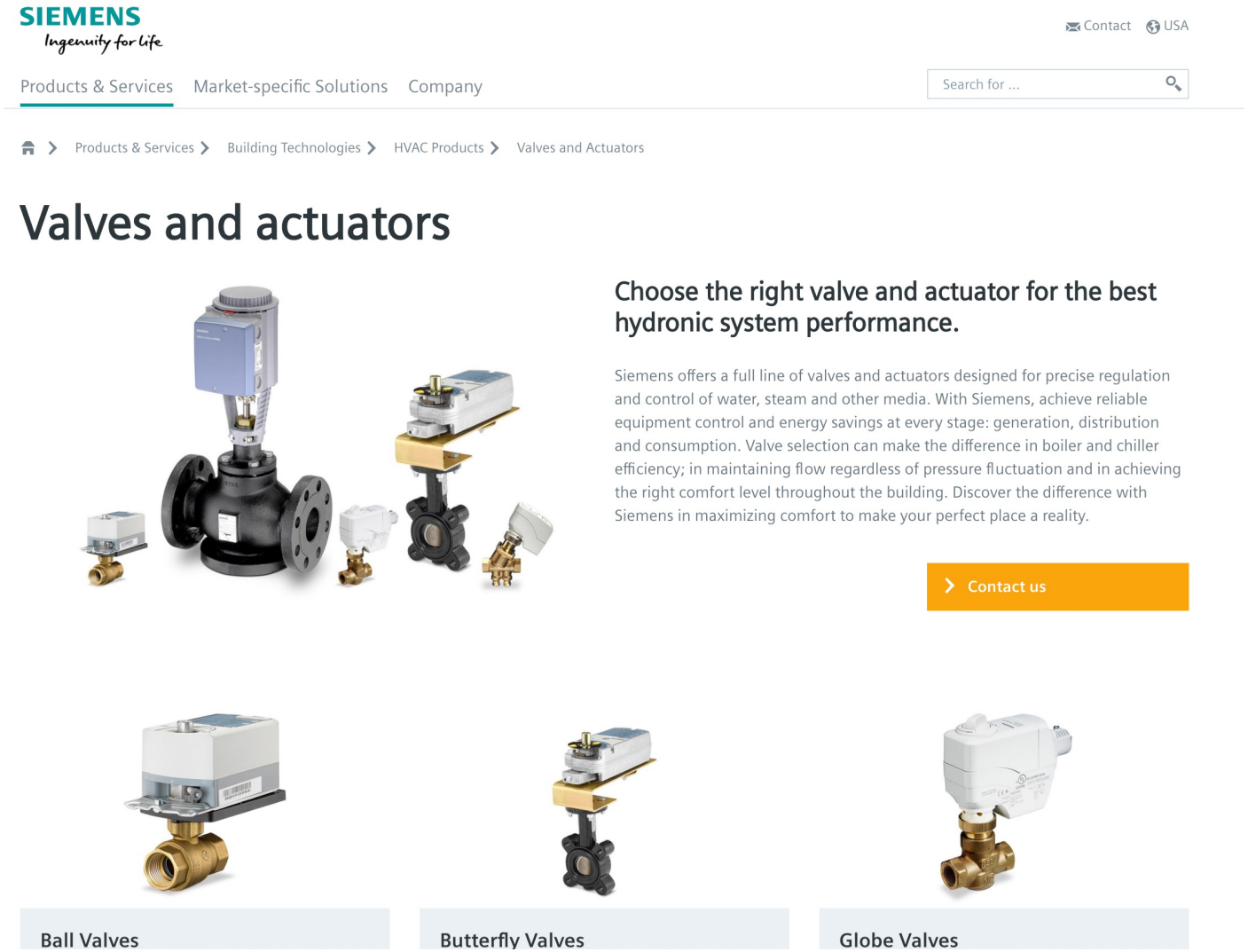
Class Activity

- Form 2-3 breakout groups
- Fill in the spreadsheet (at 3 different vendors, let's consider each valve type

https://docs.google.com/spreadsheets/d/1duxKfuy1kpYNJxXT6e9bHjVBBqUXnwBSBuR8Dkz4f7c/edit#gid=1540160475

Class Activity

- Let's look at some manufacturers



https://new.siemens.com/us/en/products/buildingtechnologies/hvac/valves-actuators.html

Class Activity

- Let's look at some manufacturers

Honeywell | Building Controls

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Home > Dampers, Actuators & Valves > Valves & Valve Actuators

Globe Valve Linkage

No Valve Disassembly Required

- Used with 2-way and 3-way globe valves in modulating or two-position service.
- Quick and simple installation with no disassembly required.
- Heavy-duty steel rack and pinion construction and aluminum die-cast housing.
- Maintenance-free construction.
- Flexible actuator mounting orientation.
- Adjustable manual override lever and valve position indicator.
- Available for 1/2 in. through 6 in. globe valves made by most manufacturers.
- Used with Honeywell MS and MN Spring and Non-Spring Actuators.
- Globe Valve Linkage
- Simplify quoting this product with CPQ Select

Pressure Independent Control Valves

Deliver high efficency in less time

- Pressure independent control valves balance the system at every point over the range of the control valve within 5% accuracy
- Control flow exactly at all load conditions, not just at design conditions
- High Turn-Down Ratio/Equal Percentage Flow results in linear heat transfer for optimal control. The characterized insert is integral to the ball, resulting in longer service life and higher differential pressure capabilities.
- Less torque is needed, so you can use lower-cost, low-torque actuators on larger pipe sizes
- No Cv calculation required - just pick the valve that matches the flow requirements - Flow range of 1 to 95 gpm
- Field serviceable stem allows valve to be serviced in the field rather than cut from the pipe
- Optional test ports facilitate system set-up for balancing report
- Manual override to control valve during installation or in the event of power failure
- Full range of sizes from 1/2" to 6"

Control Ball Valves

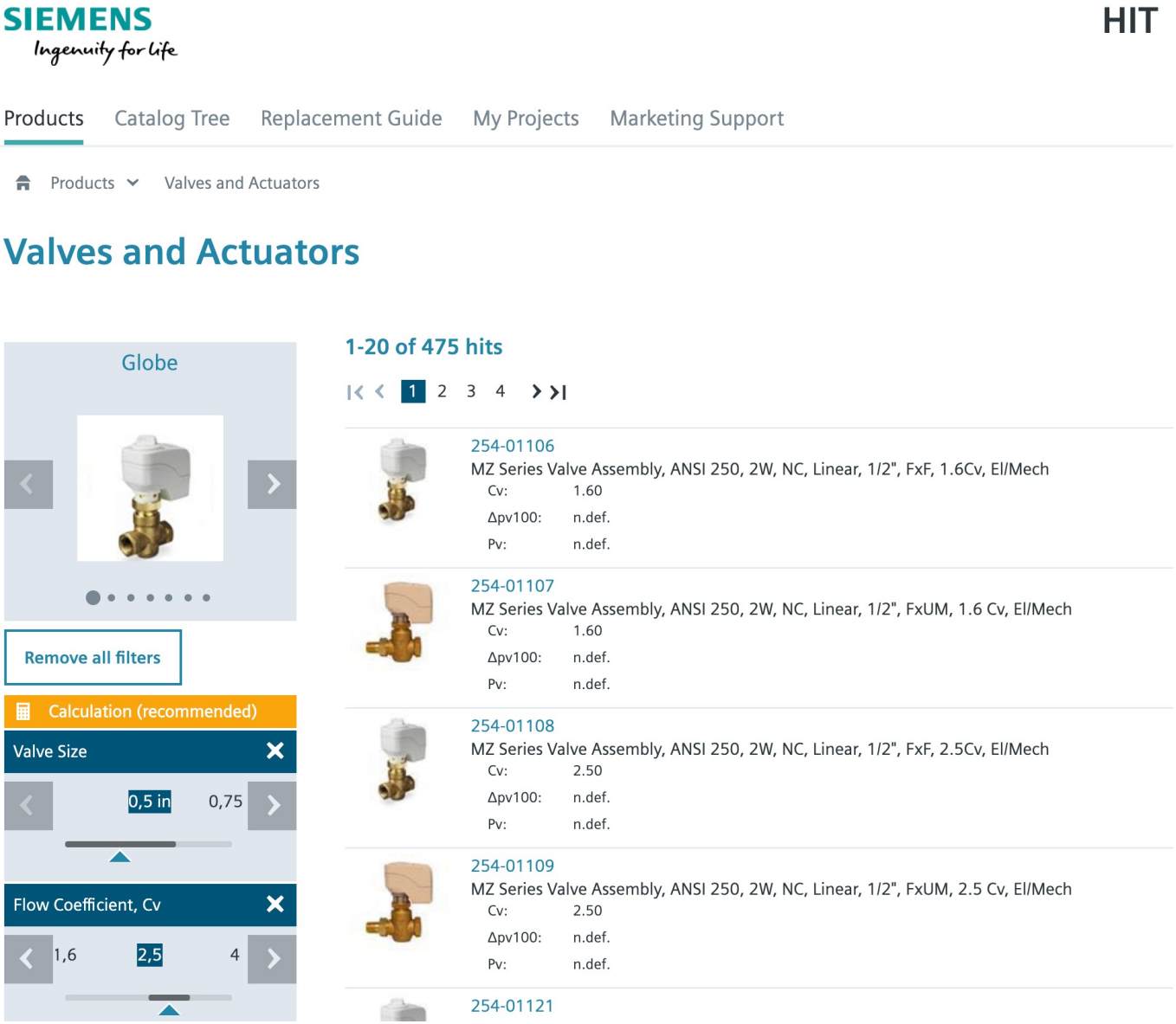
Cover every application with one control valve brand

- VBN/VBF Control ball valves control hot and chilled water in HVAC systems to provide two-position, floating, or modulating functions.
- Order them with or without factory-mounted non-spring return or spring return direct-coupled actuators.
- Flanged control ball valve offering available (VBF)
- Accurate flow control
- Simplified actuator selection with a large range of Cvs
- Built for safety and endurance with a blowout-proof stem to withstand high pressure and optional NEMA 3R enclosure for weatherproofing
- Field replaceable stem allows valve to be serviced and replaced on the pipe
- Threaded 2-Way models up to 3" and 3-Way models up to 2-1/2"
- Parabolic flow insert constructed into the ball provides high quality seals and precise control
- Multi-actuator mounting bracket allows the same bracket to be utilized on all valves
- Product Resources for Control Ball Valves

https://buildingcontrols.honeywell.com/subcategory/Dampers-Actuators-Valves/Valve-Actuators

Class Activity

- Let's look at some manufacturers



Class Activity

- Let's look at some manufacturers

VALVES AND ACTUATORS

Our HVAC Control Valves and Actuators are critical components in an end-to-end system, and their efficiency is an important factor in overall system efficiency. Choose from thousands of valve and actuator combinations that are built to deliver efficient, dependable, long-lasting and leak-proof performance. Our consistent designs and convenient built-in operating features provide outstanding control – without the need for field add-ons.

VIEW OUR FULL PRODUCT CATALOG | CONTACT US TO LEARN MORE

Greater efficiency and comfort begin with the control valve

Deliver a stable flow, regardless of pressure fluctuations, with the new VP140 Series of Pressure Independent Control Valves (PICVs). By combining a pressure regulator, a regulating valve and a control valve, it increases occupant comfort and system efficiency without the need for balancing valves. The VP140 Rotary (Ball) Valve is ideal for applications that require enhanced flexibility for seasonal commissioning and different room layouts, and the VP140 Compact Axial (Globe) Valve is designed for applications where a compact valve and actuator footprint is needed. All models deliver reduced installation, commissioning and operational costs.

DOWNLOAD THE VP140 BROCHURE | WATCH RECORDED WEBINAR

https://www.johnsoncontrols.com/building-automation-and-controls/hvac-controls/valves-and-actuators