FERGUSON INDUSTRIAL

THE BLUE BOOK

TECHNICAL RESOURCE FOR VALVES, AUTOMATION, AND INSTRUMENTATION

FERGUSON INDUSTRIAL IS A LEADING NORTH AMERICA DISTRIBUTOR OF PIPE, VALVES, FITTING AND AUTOMATED VALVES.

We stock products to service all industries including Chemical, Oil and Gas, Mining, Pulp and Paper, Power Generation, Food and Beverage and General Industry. Ferguson Industrial has 145+ locations in the USA and Canada to service our customers locally. Ferguson Industrial stocks many highly approved and well known Valve and Automation Manufacturers to reduce lead times and service our customers timely.

Ferguson Industrial team members are always available to assist our customers with proper selection for your Valve and Automation products. Our goal for this booklet is to provide general information on different types of valves, actuators and accessories commonly used by our customers. Additional information regarding common terms, specifications, and definitions for the industry are included for reference.

We hope you will find this information helpful. Please contact your local Ferguson Industrial location for additional information regarding Valve and Automation needs.

DISCLAIMER: This booklet is general reference material only. Ferguson Industrial assumes no responsibility for errors or omissions. Every effort has been made to preserve accuracy, but ALWAYS refer to current standards and specifications.

WE ARE HERE TO HELP.

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			Segment Ball Valve
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			Sanitary Butterfly Valve
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			Sanitary Butterfly Valve

A. A Liquid is a nearly incompressible fluid that conforms to the shape of its container but retains a (nearly) constant volume independent of pressure.

B. A Gas is a state of matter that has no fixed shape and no fixed volume. Gases have lower density than other states of matter, such as solids and liquids.

C. A Solid is a state of matter characterized by particles arranged such that their shape and volume are relatively stable. The constituents of a solid tend to be packed together much closer than the particles in a gas or liquid.

VALVE SELECTION GUIDE

Medium Type	Nature of Fluid	Valve Function	Recommended Valve Types
A: LIQUID	Gasoline, Crude Oil, Refined Products	On/Off	Ball Valve
			Trunnion Ball Valve
			High Performance Butterfly Valve
			Gate Valve
			Parallel Slide Gate
			Through Conduit Gate Valve
			Metal Seated Ball Valve
			Triple Offset Valve
			Twin Seal Plug Valve
		Modulating, Throttling	High Performance Butterfly Valve
			Globe Valve
			V-Port Characterized Ball Valve
			Segment Ball Valve
	White Liquor, Green Liquor, Black Liqour	On/Off	Knife Gate Valve
			High Performance Knife Gate Valve
			Diaphragm Valve
			Segment Ball Valve
		Modulating, Throttling	High Performance Knife Gate Valve
			Diaphragm Valve
			Segment Ball Valve
			V-Port Characterized Ball Valve
			Globe Style Control Valve
	Asphalt & Heat Tracing Oil	On/Off	High Performance Butterfly Valve
			Lubricated Plug Valve
			Triple Offset Valve
	River Water, Waste Water, Slurries, Pulp & Paper	On/Off	Resilient Seated Butterfly Valve
			Knife Gate Valve
			High Performance Knife Gate Valve
			Segment Ball Valve
			Pinch Valve

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VALVE SELECTION GUIDE

Medium Type	Nature of Fluid	Valve Function	Recommended Valve Types
B: GASSES	Air, Nitrogen, Oxygen, Gases, Vacuum	On/Off	Ball Valve
			Resilient Seated Butterfly Valve
			High Performance Butterfly Valve
		Modulating, Throttling	Resilient Seated Butterfly Valve
			High Performance Butterfly Valve
	Natural Gas	On/Off	Lubricated Plug Valve
			Ball Valve
			High Performance Butterfly Valve
			Through Conduit Gate Valve
			Twin Seal Plug Valve
			High Performance Butterfly Valve
		Modulating, Throttling	Globe Valve
	Saturated Steam	On/Off	Ball Valve
			Gate Valve
			High Performance Butterfly Valve
			Pressure Seal Gate Valve
			Stop Check Valve
			Metal Seated Ball Valve
			Triple Offset Valve
		Modulating, Throttling	Globe Valve
			High Performance Butterfly Valve
			Segment Ball Valve
			Y-Pattern Globe Valve
			Stop Check Valve
C: SOLIDS	Abrasives, Dry Solids, Mining, Fly Ash	On/Off, Modulating, Throttling	Knife Gate Valve
			High Performance Knife Gate Valve
			Resilient Seated Butterfly Valve
			Through Conduit Gate Valve
			Metal Seated Ball Valve
			Pinch Valve

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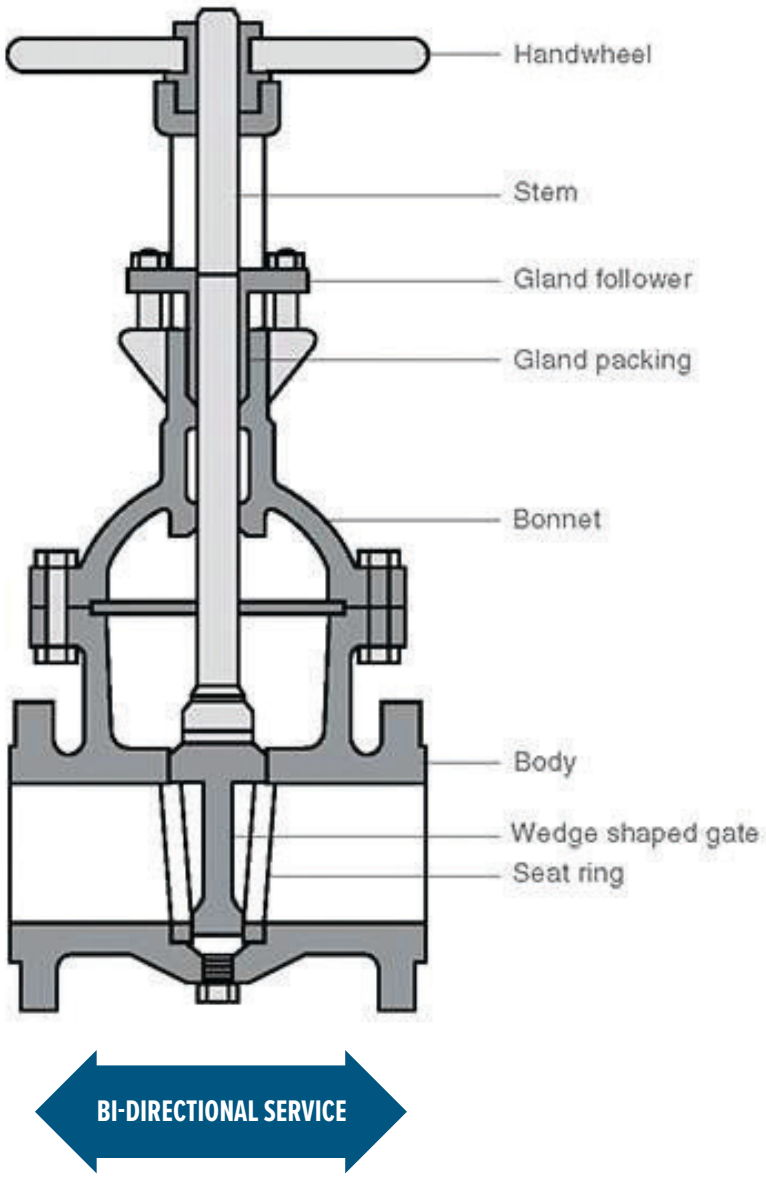
GATE VALVE



PROS:

- Bi-Directional Flow
- Slow Open and Close reduces potential for water hammer
- Less expensive than most quarter turn valves

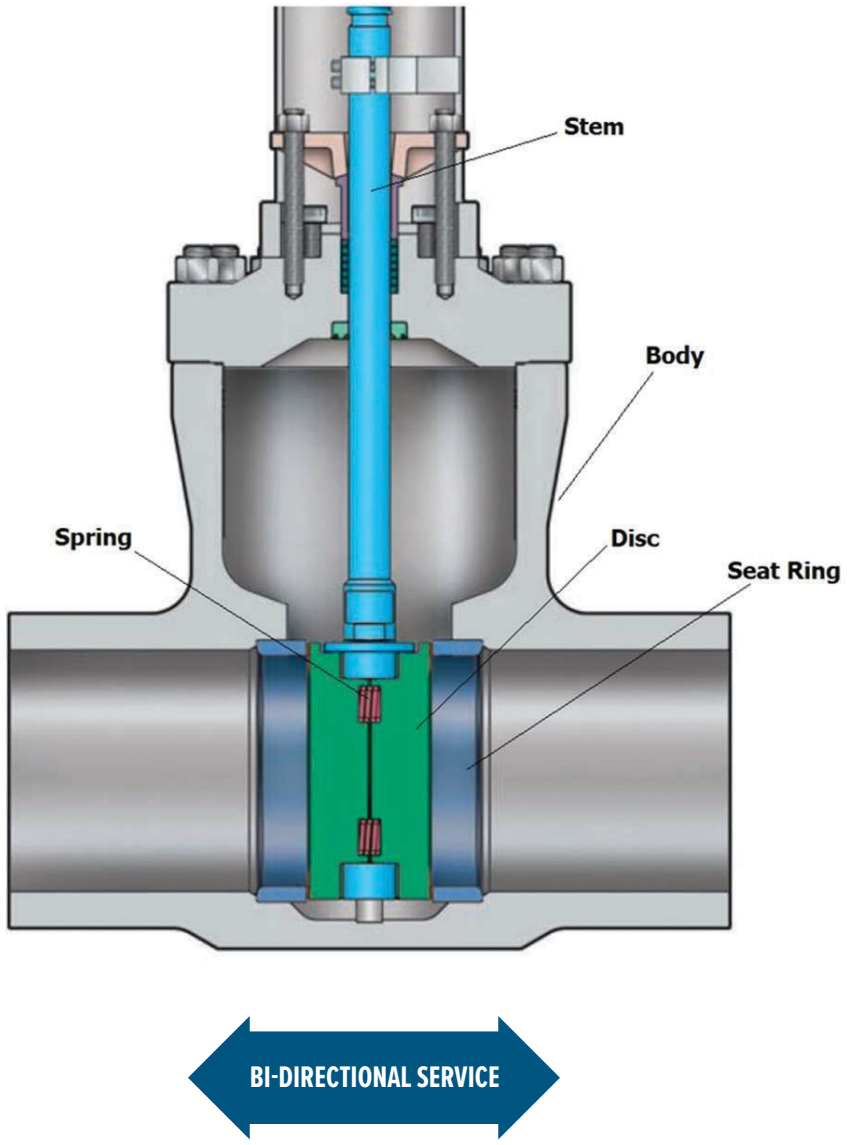
CONS:

- DO NOT use for throttling service
- Multi-Turn = Slow to Open/Close
- Shut-off is not as good as Ball/ Butterfly valves
- More difficult to automate than quarter turn valves

SERVICES INCLUDE:

- Water
- Saturated Steam
- Clear Liquids
- Slurries
- Petroleum Applications
- On/Off Service

PARALLEL SLIDE GATE VALVE



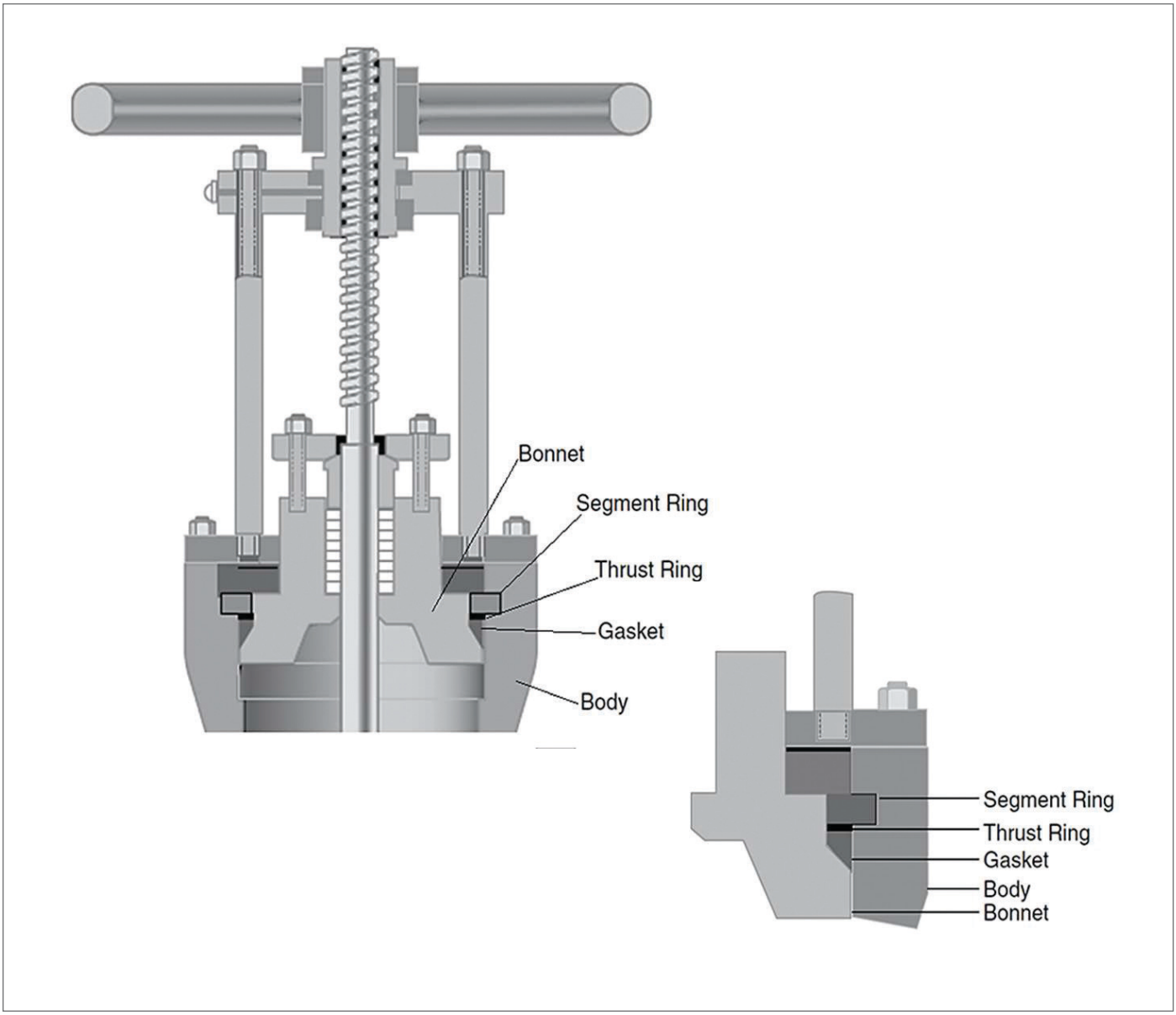
NOTES:

- Bi-Directional Flow
- Multi-Turn operation
- Available in Class 600 through Class 2500
- Not subject to Thermal Binding concerns

SERVICES INCLUDE:

- Steam Service
- Pipeline Block Valves
- Oil & Gas

PRESSURE SEAL VALVES (VARIOUS TYPES)



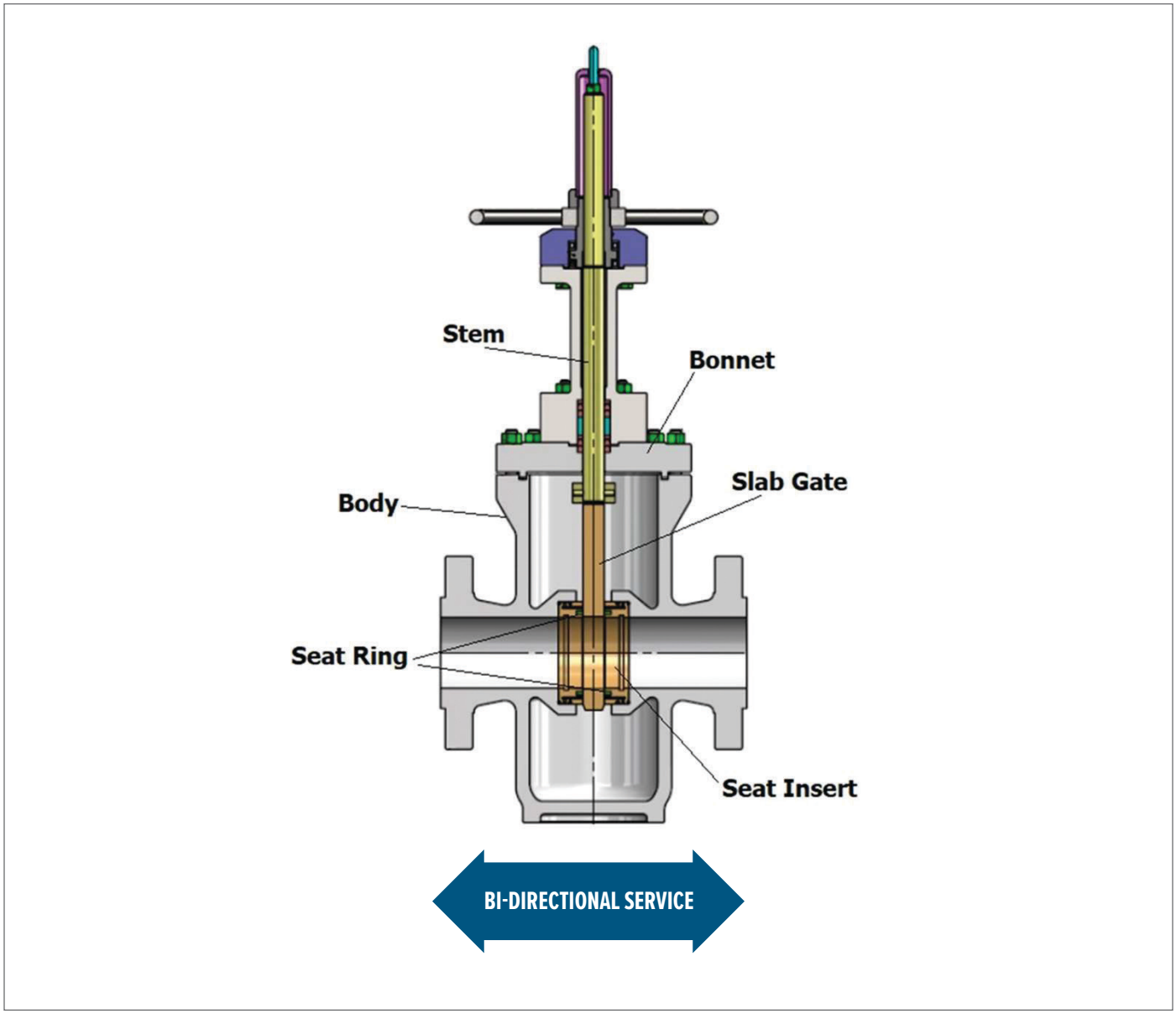
NOTES:

- This design requires pressure inside the valve to energize the gasket seal
- Does not seal well at lower pressures
- Designed to eliminate the huge amount of mass required for high-pressure bolted bonnet connections in class 600 and higher valves
- Higher the internal pressure, the better the seal
- Available in Wedge Gate, Parallel Disc Gate, Globe, Y-Globe, Stop Check, Swing Check, Tilting Disc Check and Lift Check designs
- Classes 600 through 4500

SERVICES INCLUDE:

- High Pressure Steam
- Thermal & Cogeneration Power Plant
- Nuclear Power Plants
- Chemical and Petrochemical

THROUGH CONDUIT GATE VALVE



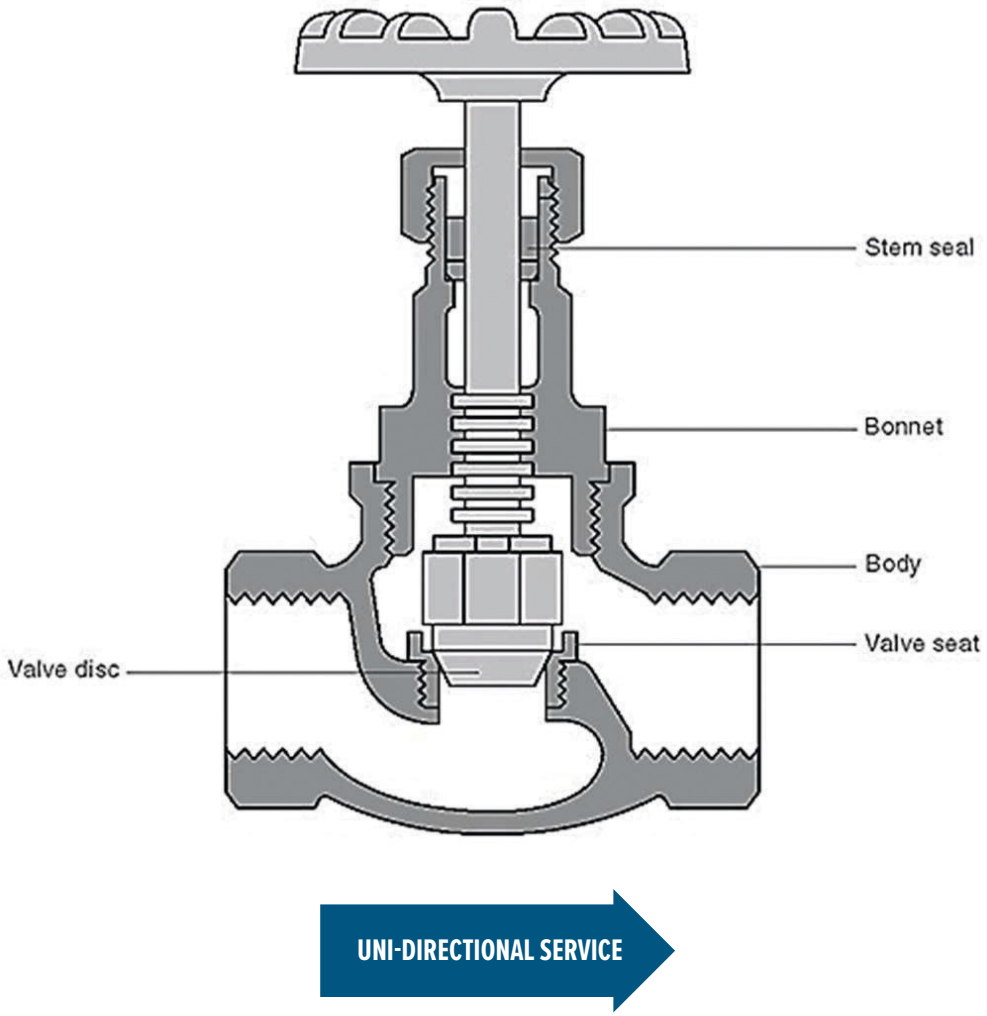
NOTES:

- Bi-Directional Flow
- Multi-Turn operation
- Double Block & Bleed
- Seat Sealant Injection ports
- Automatic Cavity Relief
- Piggable (Used as a pig catcher or launcher)
- API-6D
- Firesafe Design
- Full Bore

SERVICES INCLUDE:

- Oil & Gas
- Natural Gas and LNG
- Crude Oil
- Power
- Mining

GLOBE VALVE



PROS:

- Great for Throttling Service
- Good for Steam Throttling Service

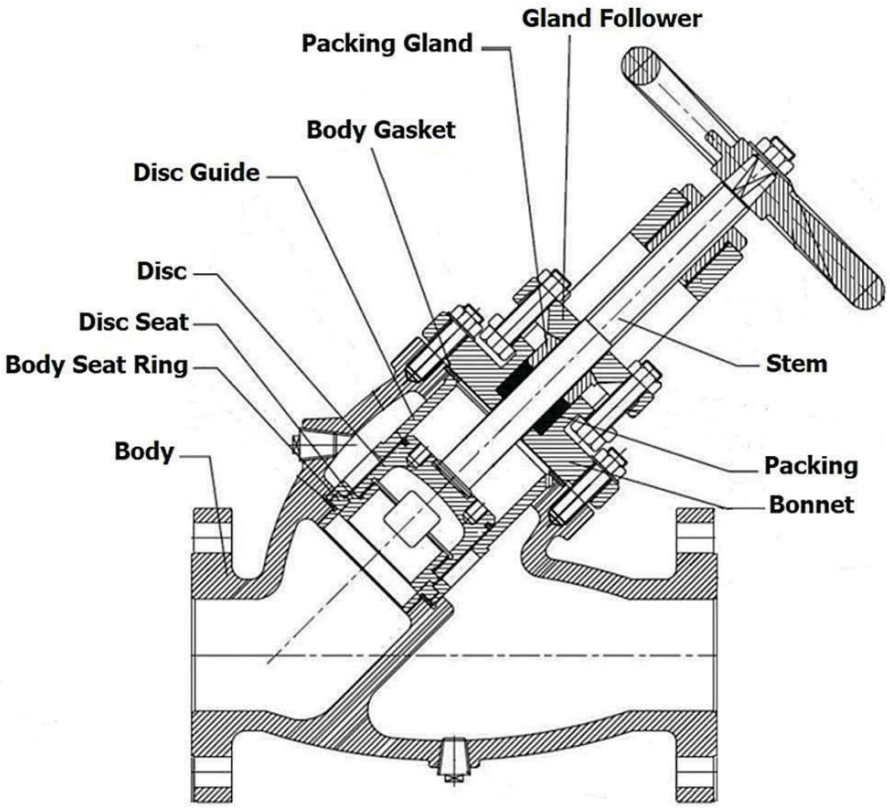
CONS:

- Not good for Isolation – On/Off service
- Multi-Turn = Slow to Open/Close
- More difficult to automate than quarter turn valves
- Do NOT use with Slurries or Solids

SERVICES INCLUDE:

- Water
- Saturated Steam
- Clear liquids
- Petroleum Applications
- Throttling Service

STOP CHECK VALVE



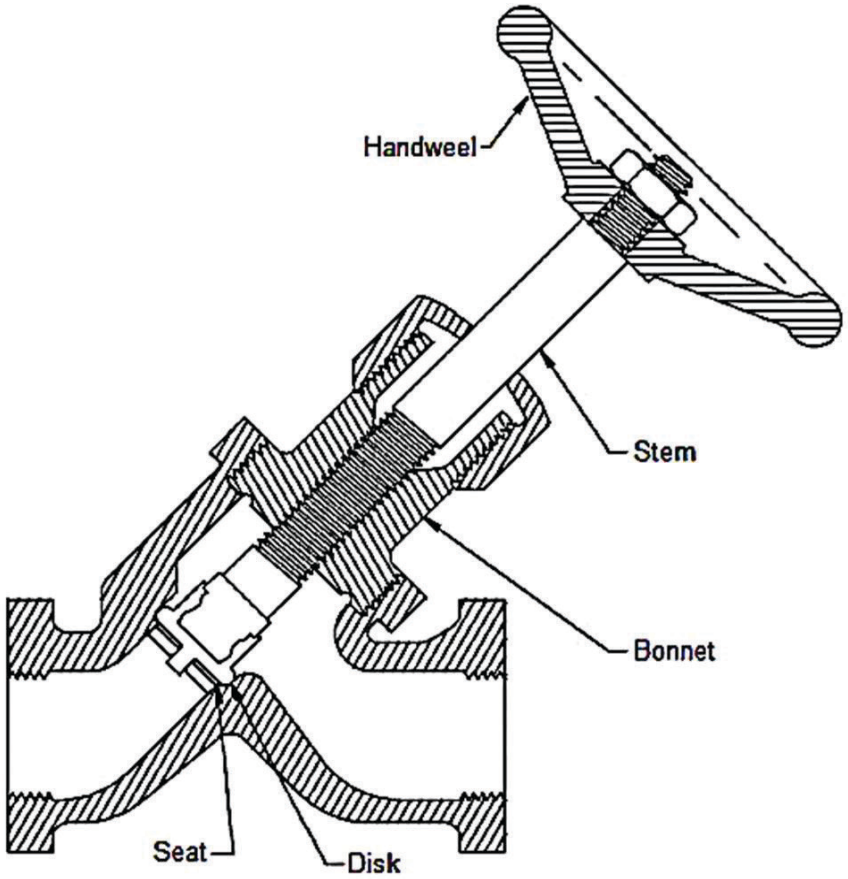
NOTES:

- Uni-Directional Flow
- Provides regulation (globe) and backflow prevention (check).
- When the un-attached disc is fully open, it functions as a check valve and restricts reverse flow
- When the disc is fully or partially opened, it functions as a traditional globe valve
- Available in “T” and “Y” patterns
- Commonly used as the first valve off of a boiler

SERVICES INCLUDE:

- Steam

Y-PATTERN GLOBE VALVE



PROS:

- Great for Throttling Service
- Good for Steam Throttling Service
- Used in Blowdown Services
- High Pressure and High Temp Designs
- Has a higher flow rate (Cv) than standard globe valves

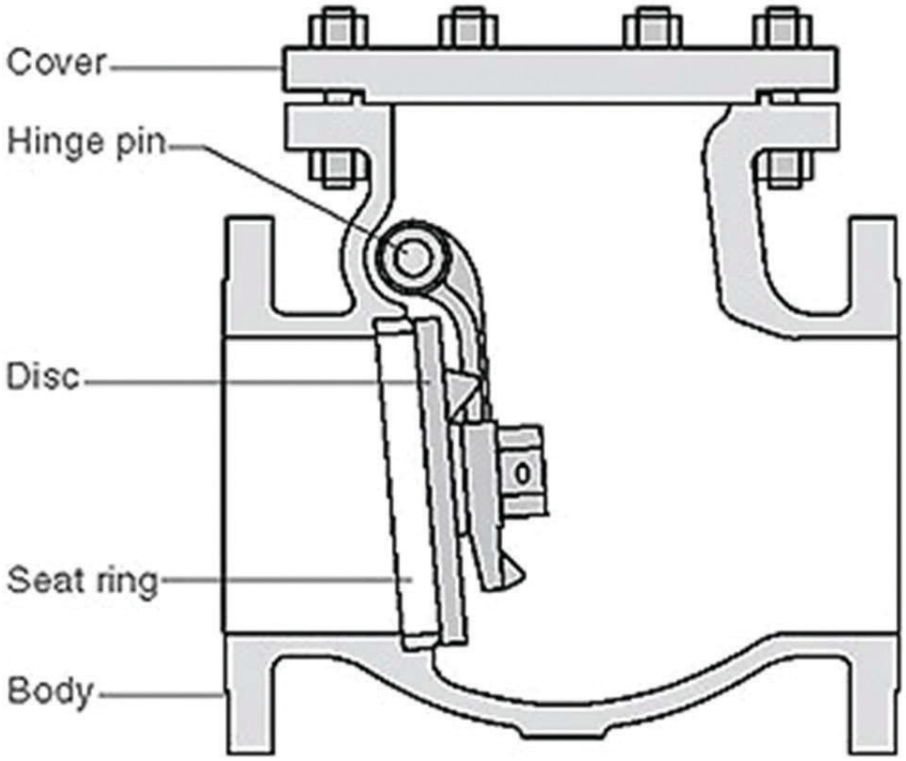
CONS:

- More difficult to automate than quarter turn valves
- Do NOT use with Slurries or Solids

SERVICES INCLUDE:

- Water
- Saturated Steam
- Throttling Service

SWING CHECK VALVE



UNI-DIRECTIONAL SERVICE

PROS:

- Used to prevent reverse flow in pipelines
- Used in Horizontal service or Vertical upward flow (not for vertical downward flow)

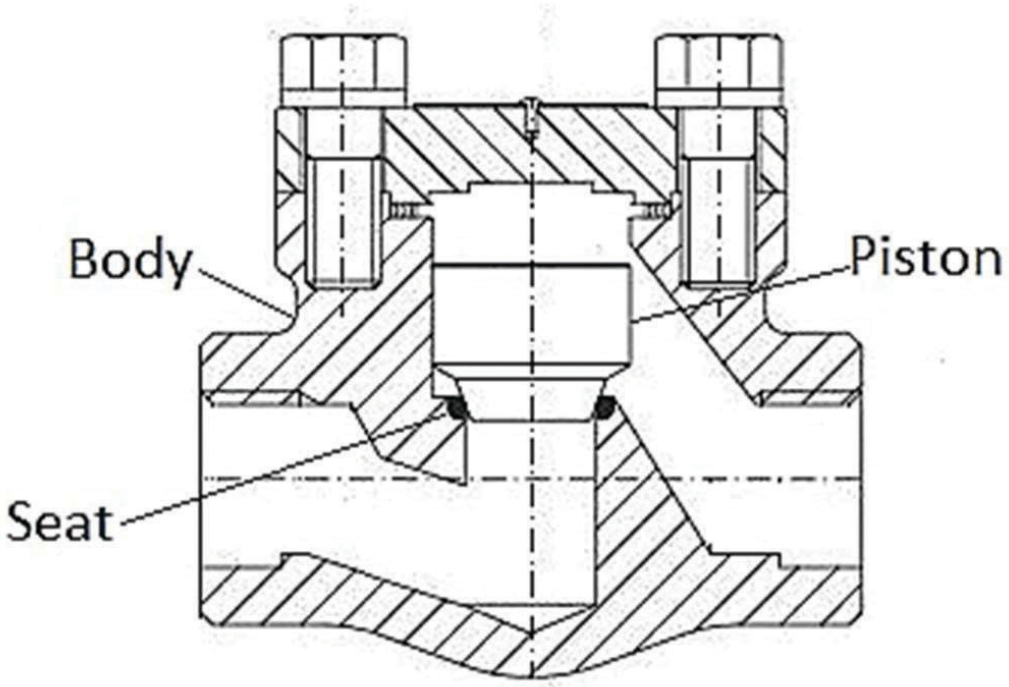
CONS:

- Can “slam” closed, causing potential damage to the valve, over time.

SERVICES INCLUDE:

- Water
- Saturated Steam
- Clear Liquids
- Slurries
- Petroleum Application

PISTON CHECK VALVE



UNI-DIRECTIONAL SERVICE

PROS:

- Used to prevent reverse flow in pipelines
- Used in Horizontal service or Vertical upward flow with an added spring (not for vertical downward flow)

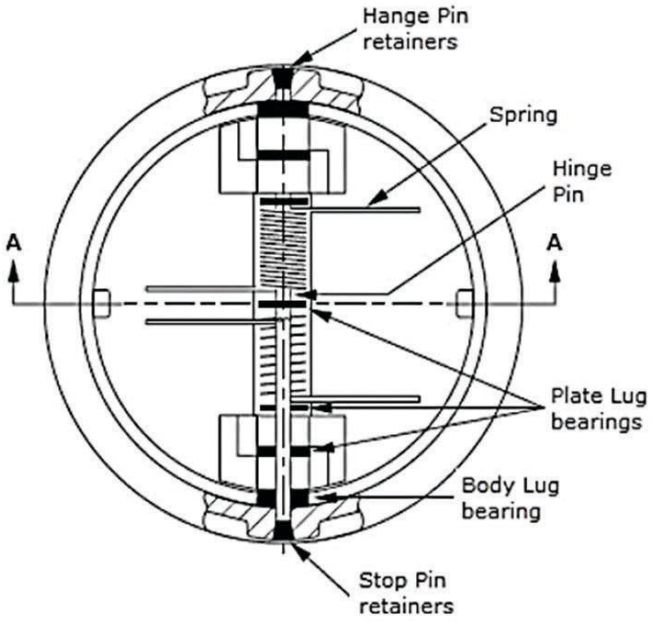
CONS:

- Has a lower flow rate (Cv) than swing check valves.

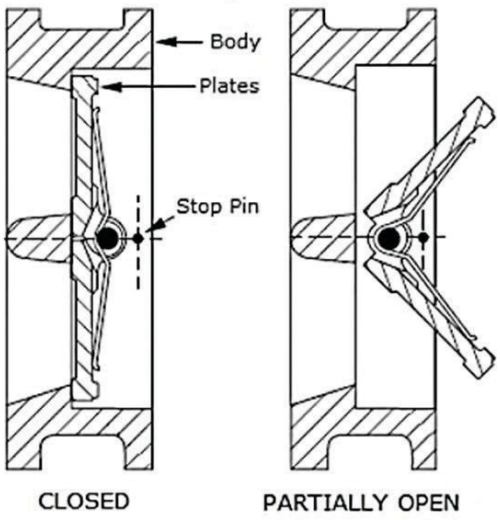
SERVICES INCLUDE:

- Water
- Saturated Steam
- Clear Liquids
- Petroleum Applications

DUAL PLATE CHECK VALVE



UNI-DIRECTIONAL SERVICE



PROS:

- Used to prevent reverse flow in pipelines
- Used in Horizontal service or Vertical upward flow (not for vertical downward flow)
- Lighter weight and More Economical than full bodied swing check valves
- Elastomeric seats available for tight shutoff
- Non-Slam design

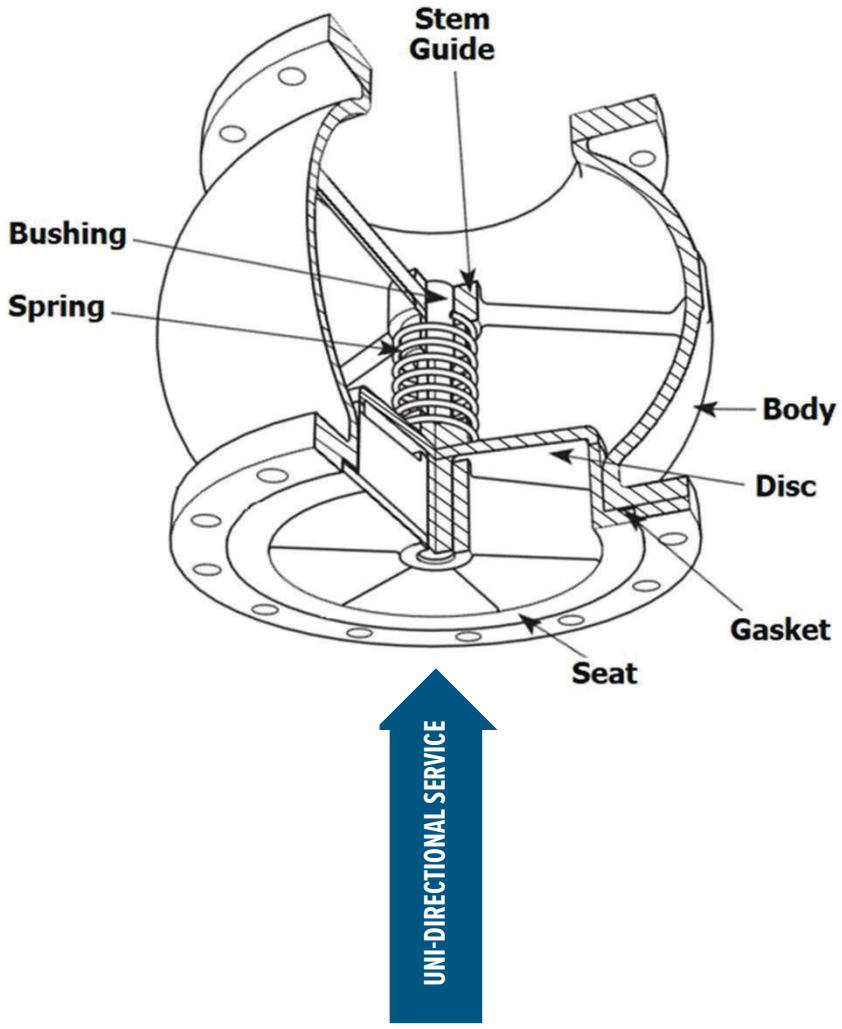
CONS:

- Check valve plate and retainer remains in the flow path causing a higher pressure drop

SERVICES INCLUDE:

- Water
- Saturated Steam
- Clear Liquids
- Petroleum Applications

CENTER GUIDED GLOBE CHECK VALVE



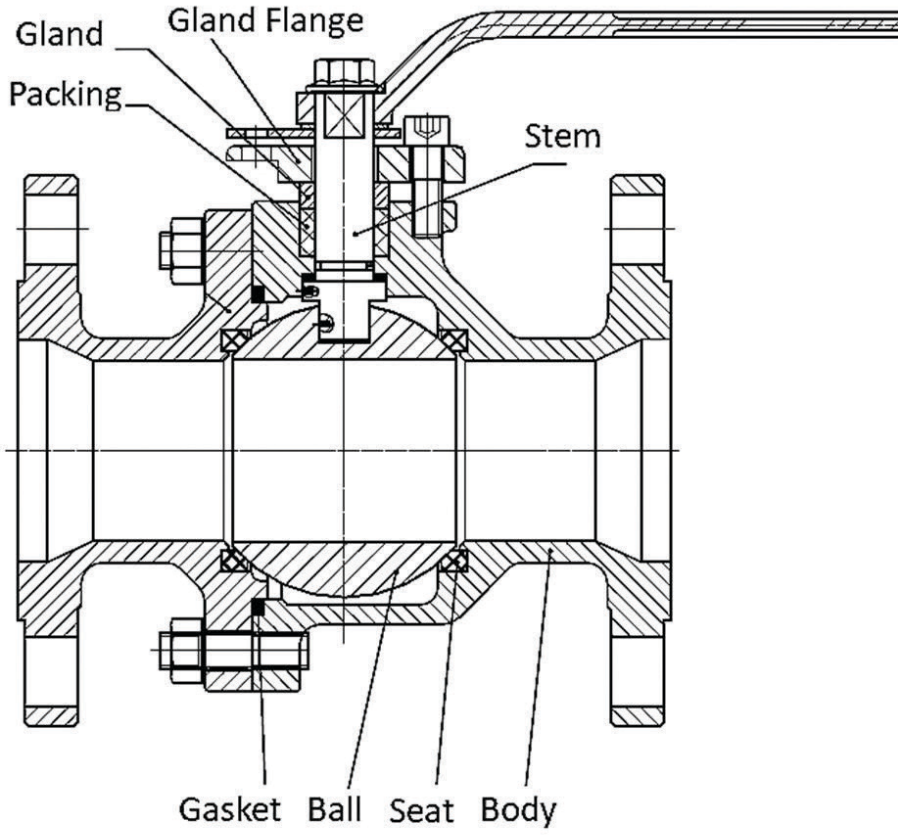
NOTES:

- Used to prevent reverse flow in pipelines
- Used in Horizontal service or Vertical upward flow (not for vertical downward flow)
- Silent Check will not slam closed
- Ductile Iron, Carbon Steel and Stainless Steel Construction, available
- Water Hammer is less likely with this design

SERVICES INCLUDE:

- Water
- Clear Liquids
- Petroleum Applications
- Chemical

BALL VALVE (FLOATING BALL)



PROS:

- Most common design is soft seated
- Bubble tight Shutoff, with soft seats – Exceeds Class VI
- Quarter Turn operation – Quick open/close
- Easy to Automate
- Standard Port and Full Port options available
- 3-way and 4-way port options available

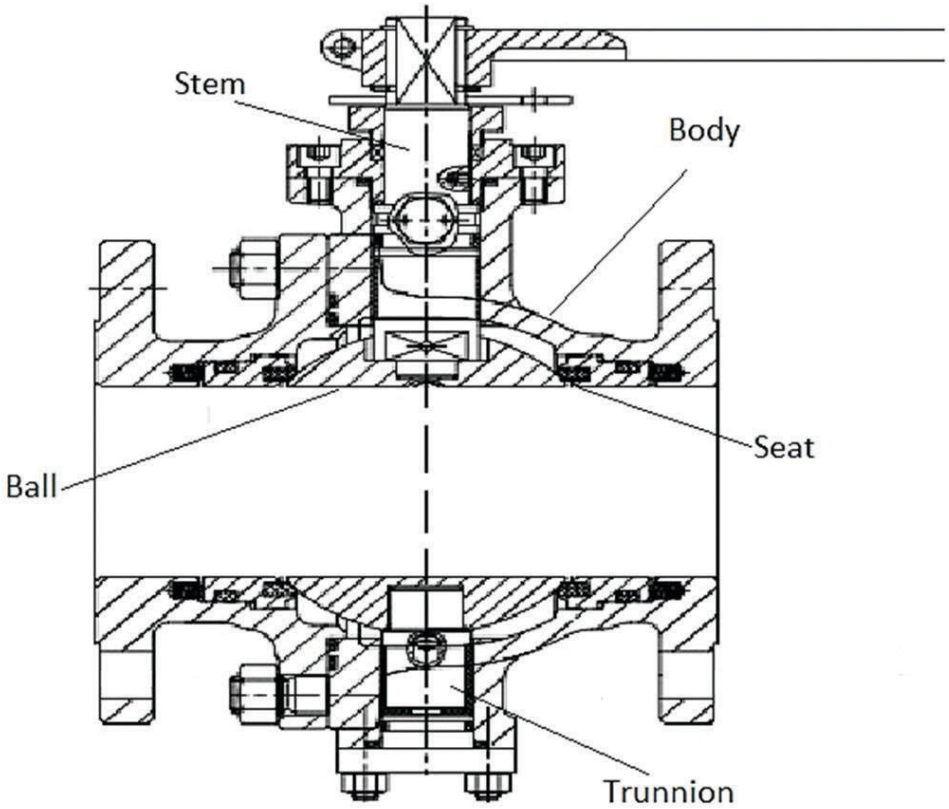
CONS:

- Not good for throttling service
- Limited to 12” size and Class 600
- Do not use with slurries, solids or abrasive applications

SERVICES INCLUDE:

- Water
- Saturated Steam
- Clear Liquids
- Acids / Bases (materials dependent)
- Air / Nitrogen / other gases
- Natural Gas
- Petroleum Applications
- On/Off Service

TRUNNION VALVE



BI-DIRECTIONAL SERVICE

PROS:

- Bi-Directional Flow
- Bubble tight Shutoff – Exceeds Class VI
- Quarter Turn operation – Quick open/close
- Easy to Automate
- Full Port option is Piggable
- Larger Sizes and Higher Pressure Classes available
- Double Block & Bleed Design

CONS:

- Not good for throttling service
- Do not use with slurries, solids or abrasive applications

SERVICES INCLUDE:

- Petroleum Applications
- Water
- Clear Liquids
- Acids / Bases (materials dependent)
- On/Off Service

SEAT MATERIALS

PTFE:

Polytetrafluoroethylene - a synthetic fluoropolymer of tetrafluoroethylene - called Teflon® by DuPont®

- Soft seat capable of tight shutoff
- Relatively inexpensive material
- Low torque characteristics
- Excellent corrosion resistance
- Impervious to most chemicals
- Good temperature resistance
- Avoid temperatures in excess of 400°F to 425°F (204°C to 218°C) (Consult pressure temperature charts in catalog.)
- Avoid high pressure (acceptable limits are defined in the pressure temperature charts for in Engineering section of catalog)
- Throttling and Erosive services should be closely examined prior to selection in order to avoid wire draw
- Not good for Styrene. Butadiene. Vinyl Chloride. Latex. Radioactive, or Erosive services

Available in all steel valves, exception, the Three-Piece valve does not offer PTFE as an option.

RPTFE:

Reinforced PTFE. RPTFE, called reinforced Teflon® by DuPont®

- Same basic performance properties as PTFE
- Reinforcing (filler materials) can be Glass Bead. Stainless Steel. 55% Bronze and 5% Molybdenum. Carbon Graphite, and more, but the most common is 15% Glass Filled
- Added structural strength
- Fillers increases operational torque more than basic PTFE
- Added erosion strength
- Service temperature should not exceed 450°F (232°C).
- (Consult pressure temperature charts in catalog.)
- Caution when using with chemicals to make sure they are compatible with the filler materials
- Not good for Styrene. Butadiene. Vinyl Chloride. Latex. Radioactive or Erosive services
- Throttling and Erosive services should be closely examined prior to selection in order to avoid wire draw

Available in all steel valves, exception, the Three-Piece valve does not offer RPTFE as an option.

UHMWPE:

Ultra-High Molecular-Weight Polyethylene

- Soft seat capable of tight shutoff
- Still a relatively inexpensive material
- Best abrasion resistance of any soft seat we offer
- Good resistance in Radiation. Butadiene and Styrene services
- Used extensively in tobacco industry because not poison like PTFE based seats when it burns
- Service temperature should be limited to 180°F (82°C) max on the upper end . (Consult pressure temperature charts in catalog.)
- Caution - not good at all in Oxidizing Acid services

This material is available as an option for all of the steel industrial valves.

PFA:

Perfluoroalkoxy

- Typically an injection molded material
- Denser material than PTFE, but has similar characteristics
- Excellent in saline water applications
- Excellent for Butadiene. Styrene. Vinyl Chloride and Latex applications
- PFA does not “popcorn like PTFE in similar applications
- Much more expensive than PTFE
- Maximum service temperature should be about 450°F (232°C). (Consult pressure temperature charts in catalog.)

This material is an option in the Top Entry valve (option “-C”)

PCTFE:

Polychlorotrifluoroethylene

- a.k.a. - Kel-F® by 3-M, today known as Neoflon® by Daikin
- Higher compressive strength than PTFE based materials
- Very low “cold flow characteristics
- Does not absorb moisture
- Very low gas permeability
- Very low shrinkage in low temperature applications
- More stable in thermal cycling applications than PTFE based materials
- Temperature limit thresholds are around 300 F (149 C)

This material is an option in the Top Entry valve (option “-C”)

MULTISEAL:

Molecularly Modified PTFE

- Also known as “Super Teflon® . Multiseal is a product of Dyneon®. more specifically Dyneon TFM™ 1600
- Low torque characteristics
- FDA approved as food service grade
- Impervious to most chemicals
- Better than PTFE in most similar services
- Fairly stable at higher service temperature 475° to 500°F (246°C to 260°C) depending upon operating pressures
- Expansion and contraction rates are higher than with PTFE in thermal cycling
- Improved resistance to “popcorning caused by polymerization of
- Butadiene. Styrene. Vinyl Chloride and Latex, but still not as good as PFA for those services.

This material is the standard seat material offering for all Three-Piece steel valves. It is also available as an optional seating material for Flanged End valves (option “-80”), and it is a common seating material for Top Entry valves (Seat “-M”. and fire safe Seat “-L”.

PEEK:

Polyether Ether Ketone

- Hard plastic like material
- Corrosion resistance similar to PTFE
- Excellent abrasion resistant material
- Good for use in higher temperature applications 500°F to 550°F I260°C to 280°C)
- High torque characteristics
- Used in tobacco as well due to not being poison like PTFE based materials when it burns
- It is recommended that the factory be consulted before specifying this material

This material is available for seats in all of the steel valves. It is also used as a stem bearing, when blended with PTFE to reduce friction. It is the standard stem bearing for all steel three-piece Apollo valves. CAUTION: Do Not use this material in Chlorine services.

CARBON GRAPHITE:

- Ball and seats are lapped as a set
- Very hard material
- Material is not flexible
- Basic carbon graphite seat material good to 750°F (399°C)
- High temperature graphite can be used to a maximum of I000°F (538°C)
- It is recommended that the factory be consulted before specifying this material

At the present time this material is only available in the Top Entry valve, and is used only as a seat material.

CERAMIC:

Partially Stabilized Zirconia (PSZ)

- Very hard, very brittle material
- Very good compressive strength
- Excellent abrasive and corrosion resistance
- High temperature services up to 900°F (482°C)
- It is recommended that the factory be consulted before specifying this material

At the present time this material is only available in the Top Entry valve, and is used only for ball and seats

SEAT MATERIALS

PCTFE

UHMWPE

MULTI-SEAL/TFM-1600

PTFE

RPTFE

CERAMIC
TEV SEAT #9

PEEK

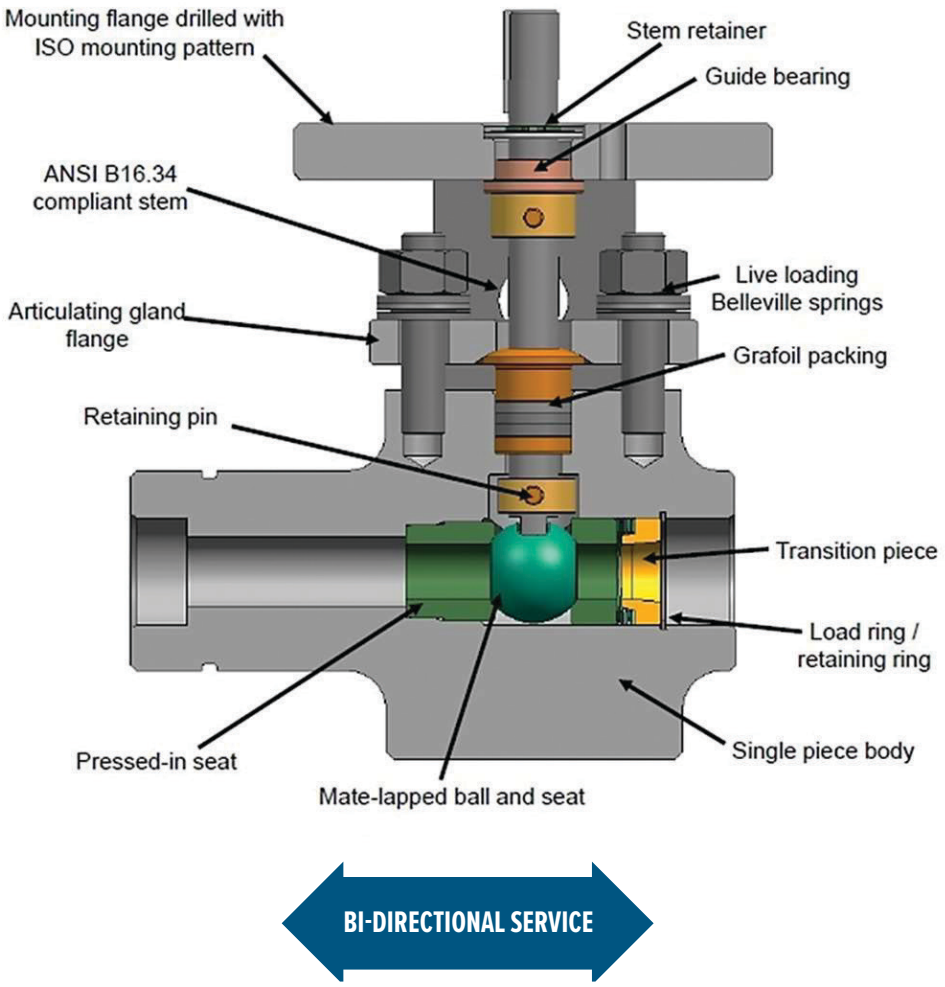
BRONZE/MOLY
TEV SEAT #5

MPTFE (MULTI-FILL)

CARBON/PEEK
TEV SEAT B

CARBON GRAPHITE
TEV SEAT #4

SEVERE SERVICE METAL SEATED BALL VALVE



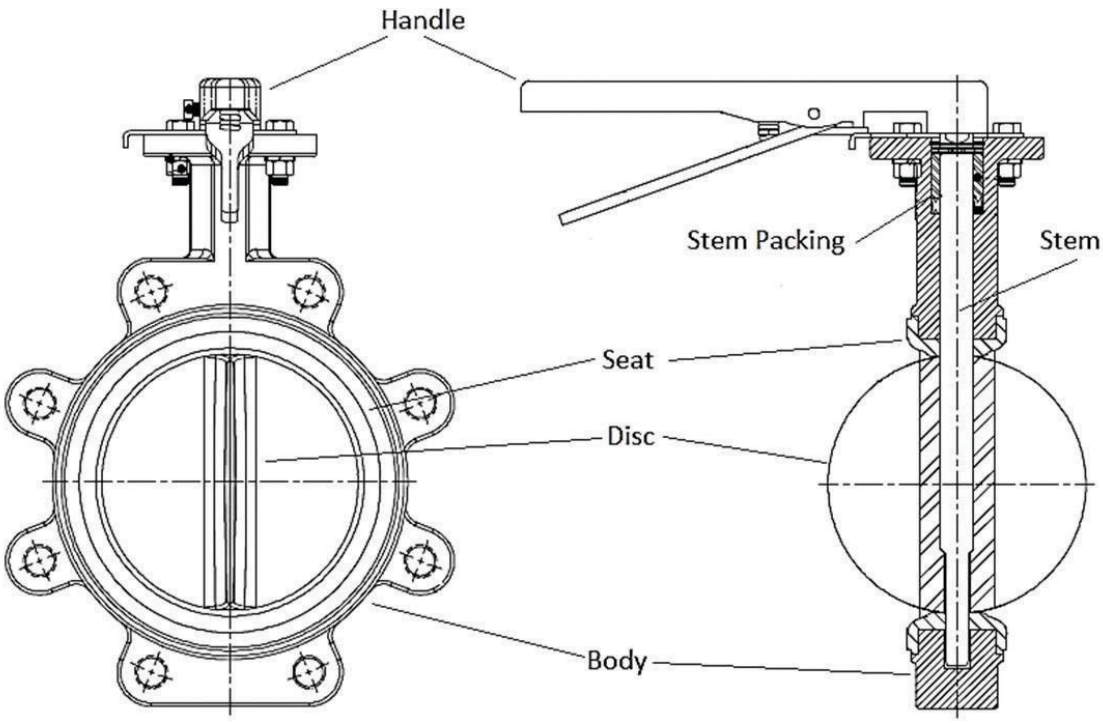
NOTES:

- Uni-Directional Flow
- Class VI Shutoff
- On/Off service - Not recommended for throttling service
- Quarter Turn operation - Quick opening and closing
- Easy to Automate
- Class 1500 through Class 4500
- A105, F22 and F91 materials
- SW ends are most common

SERVICES INCLUDE:

- Steam
- High Temperature Liquids
- Petroleum products
- Power Plant Vent and Drain
- Coker Valve
- Mining applications

RESILIENT SEATED BUTTERFLY VALVE



BI-DIRECTIONAL SERVICE

INSTALL IN THE PARTIALLY OPEN POSITION

PROS:

- Bi-Directional Flow
- Bubble tight Shutoff – Exceeds Class VI
- Quarter Turn operation – Quick open/close
- Lighter weight than ball valves
- More Economical than ball valves
- Easy to Automate
- Can be used for basic throttling service

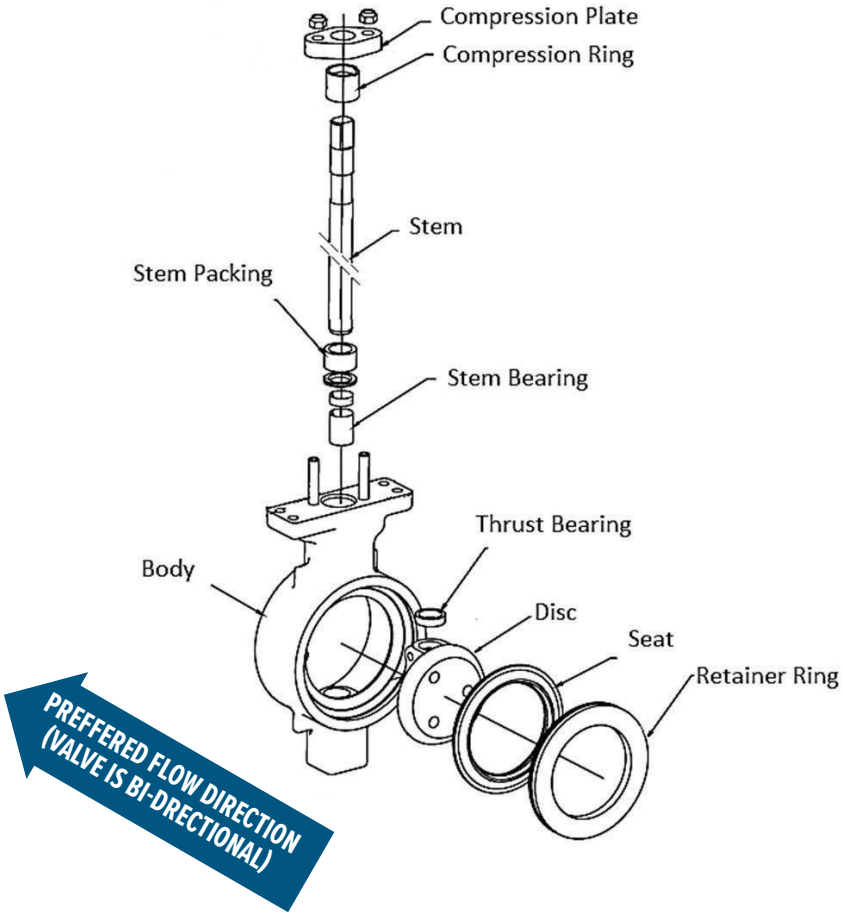
CONS:

- Not for use in steam service
- Disc remains in the flow path causing a higher pressure drop

SERVICES INCLUDE:

- Water
- Clear liquids
- Acids / Bases (materials dependent)
- Air / Nitrogen / other gases

HIGH PERFORMANCE BUTTERFLY VALVE



INSTALL IN THE FULLY CLOSED POSITION

PROS:

- Most commonly provided with a soft seat
- (Teflon or filled Teflon), but firesafe and metal seats are available.
- Bubble tight Shutoff – Exceeds Class VI
- Quarter Turn operation – Quick open/close
- Lighter weight than ball valves
- Easy to Automate
- Full ANSI Class rated
- Can be used for basic throttling service

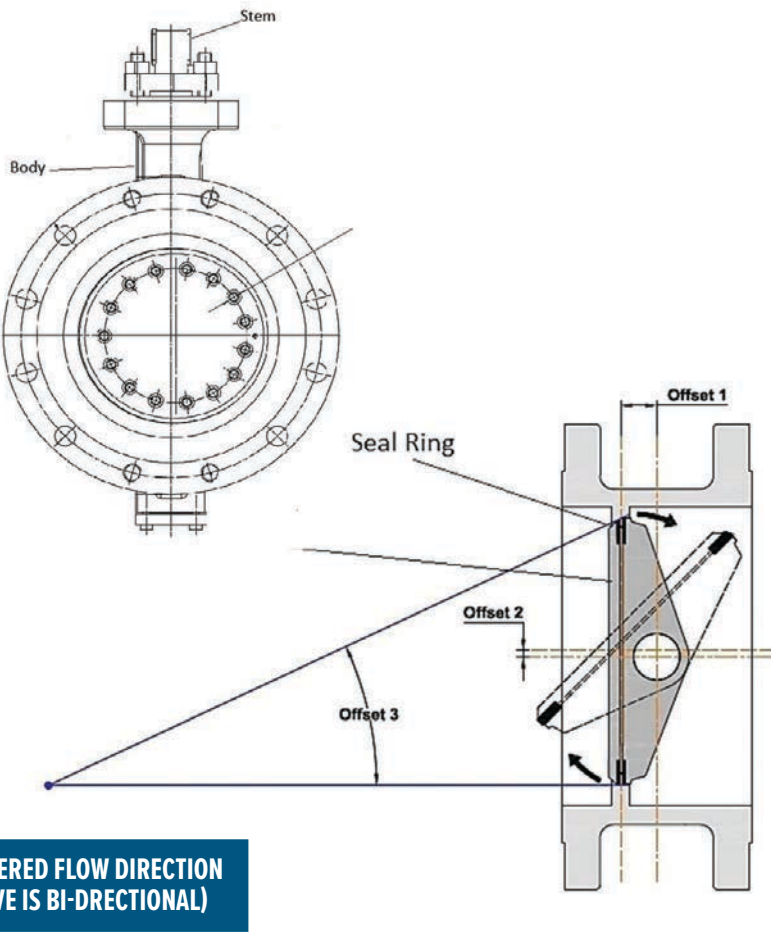
CONS:

- Disc remains in the flow path causing a higher pressure drop

SERVICES INCLUDE:

- Saturated Steam
- Petroleum Applications
- Water
- Clear liquids
- Acids / Bases (materials dependent)
- Natural Gas

TRIPLE OFFSET BUTTERFLY VALVE



PROS:

- Bi-Directional Flow with preferred flow direction
- Zero Leakage Shutoff – Exceeds Bubble Tight & Class VI
- Quarter Turn operation – Quick open/close
- Easy to Automate
- Full ANSI Class rated
- Good in higher temperatures
- Can be used for basic throttling service

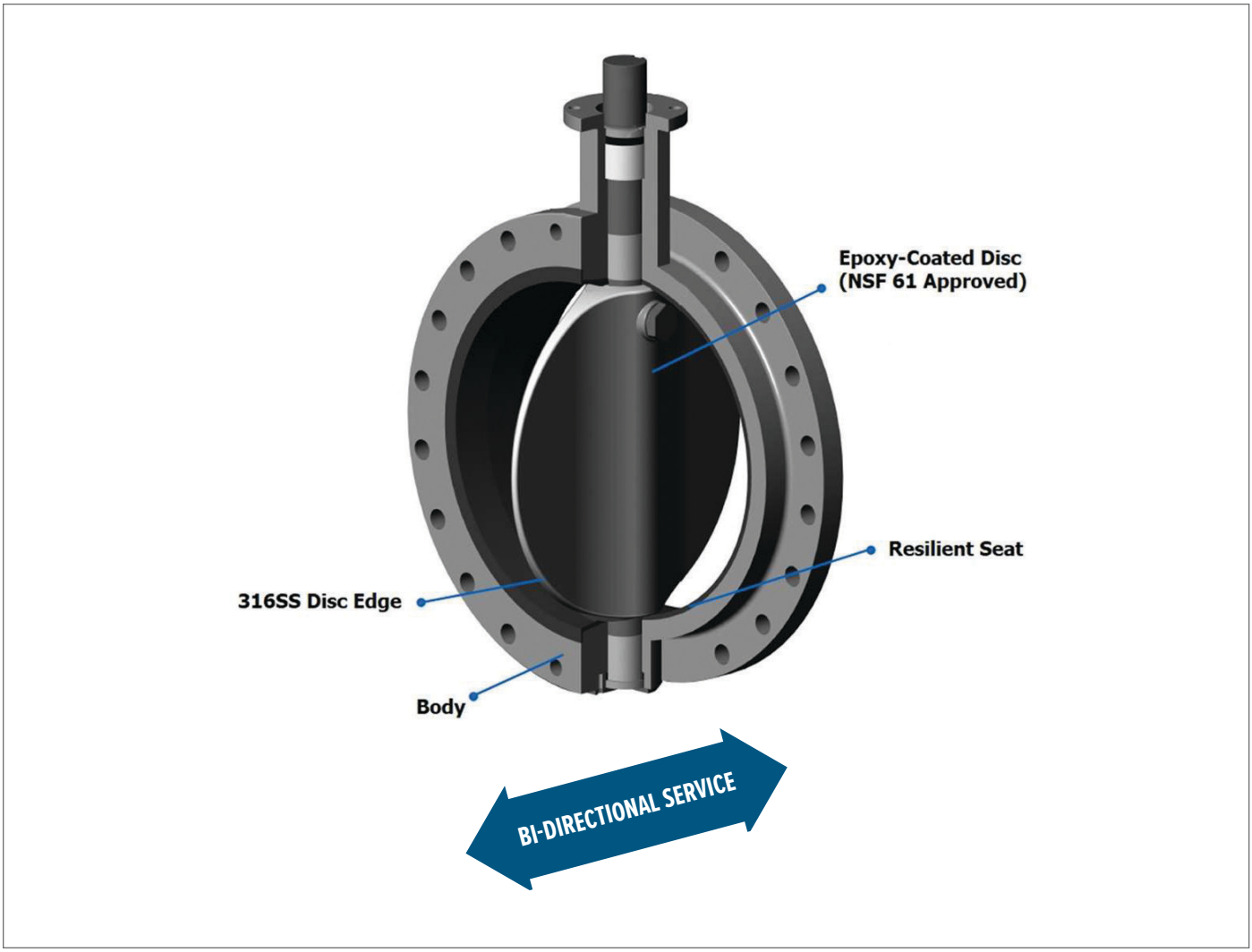
CONS:

- Disc remains in the flow path causing a higher pressure drop

SERVICES INCLUDE:

- Saturated Steam
- Petroleum Applications
- Water
- Higher Temperatures
- On/Off Service

AWWA C504 BUTTERFLY VALVE



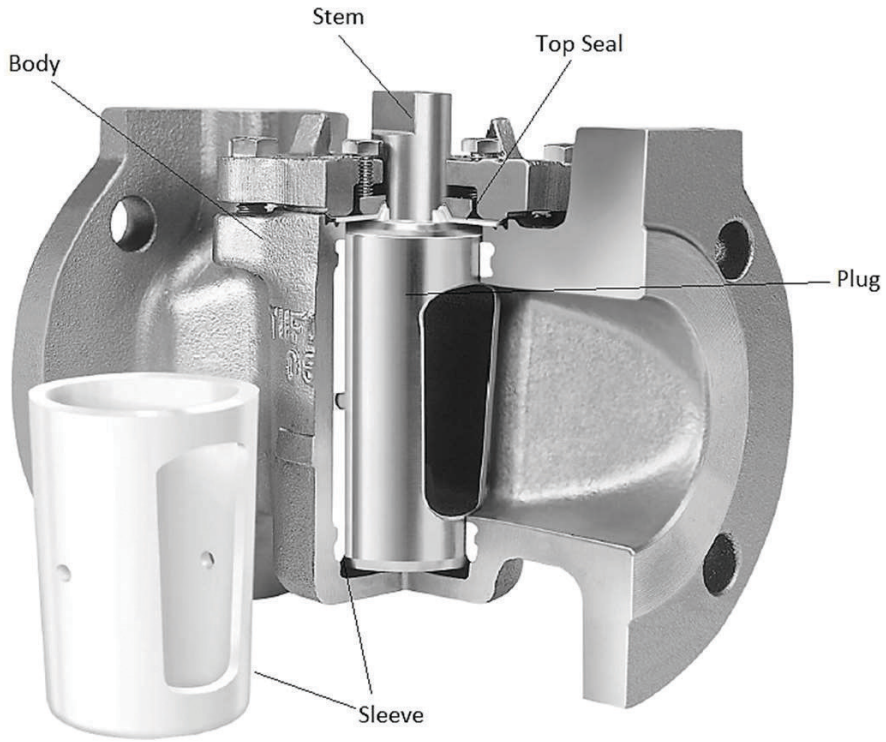
NOTES:

- Built to AWWA C504 standards
- Bi-Directional Flow
- Quarter Turn operation
- Easy to Automate
- Available in sizes 3” through 144”
- Available flg x flg and mechanical joint
- Industrial and Power industries have large valves on water intake lines

SERVICES INCLUDE:

- Municipal Water and Waste Water
- Industrial Water and Waste Water
- Power Water and Waste Water
- River Water Intake
- Cooling Tower Water Valve

SLEEVED PLUG VALVE



BI-DIRECTIONAL SERVICE

PROS:

- Bi-Directional Flow
- Bubble tight Shutoff – Exceeds Class VI
- Quarter Turn operation – Quick open/close
- Easy to Automate
- No Body Cavity
- 3-way, 4-way and 5 way port options

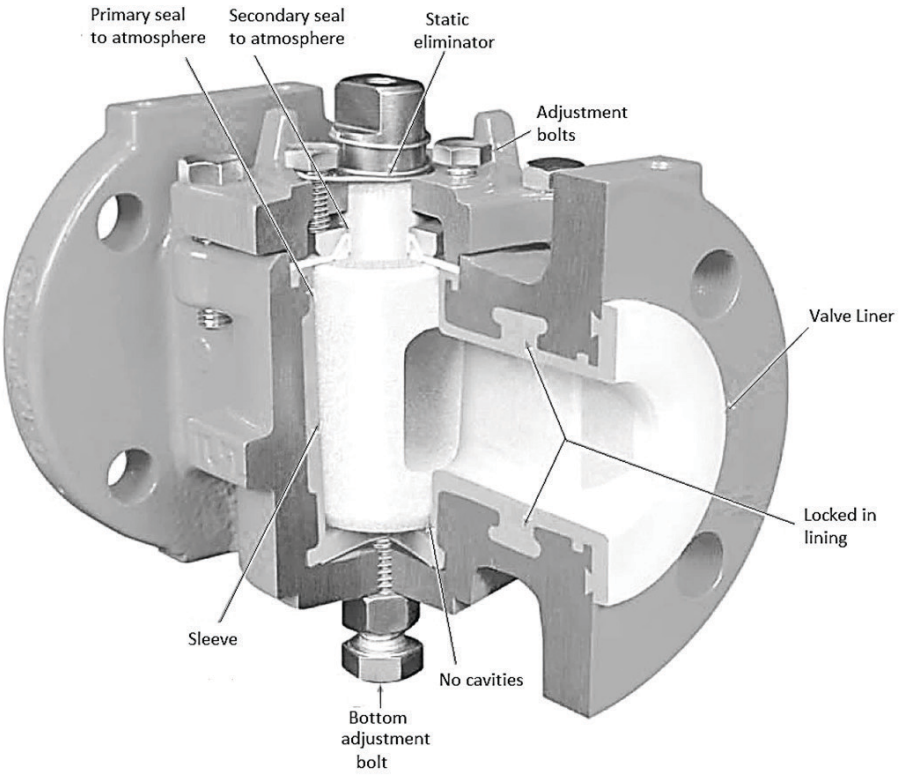
CONS:

- Not good for throttling service
- More Expensive than Ball Valves

SERVICES INCLUDE:

- Water
- Clear Liquids
- Liquids with Solids
- Acids / Bases (materials dependent)
- On/Off Service

FULLY LINED PLUG VALVE



PROS:

- Bi-Directional Flow
- Bubble tight Shutoff – Exceeds Class VI
- Quarter Turn operation – Quick open/close
- Easy to Automate
- No Body Cavity
- Good option to high alloy bodied valves
- 3-way port options

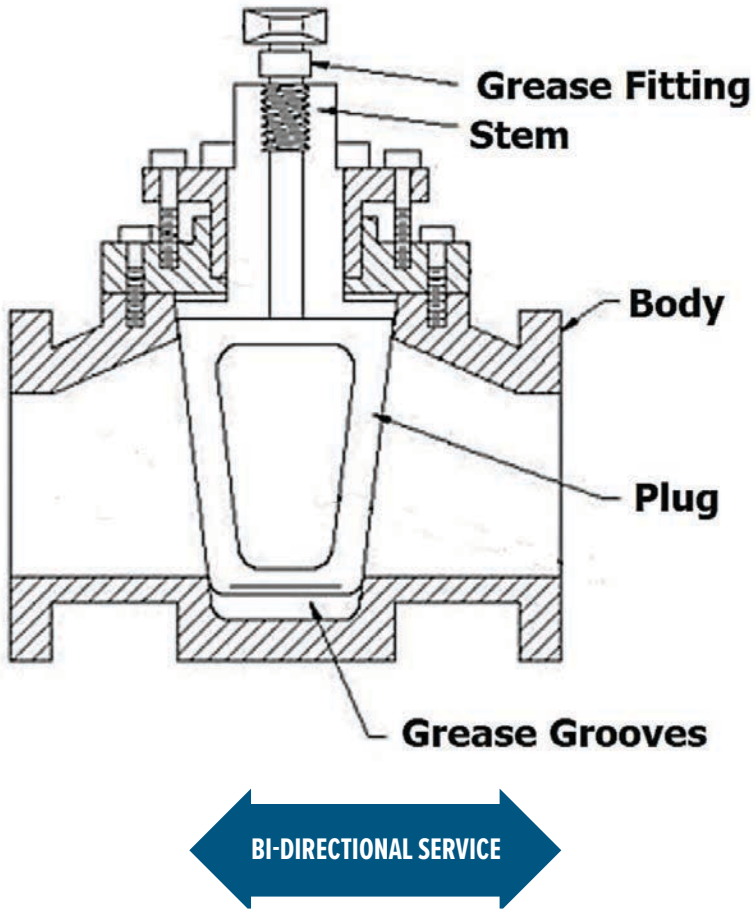
CONS:

- Not good for throttling service

SERVICES INCLUDE:

- Acids (materials dependent)
- Bases (materials dependent)
- Chemicals requiring high alloy materials
- On/Off Service

LUBRICATED PLUG VALVE



PROS:

- Bi-Directional Flow
- Bubble tight Shutoff – Exceeds Class VI
- Quarter Turn operation – Quick open/close
- No Body Cavity
- 3-way and 4-way port options

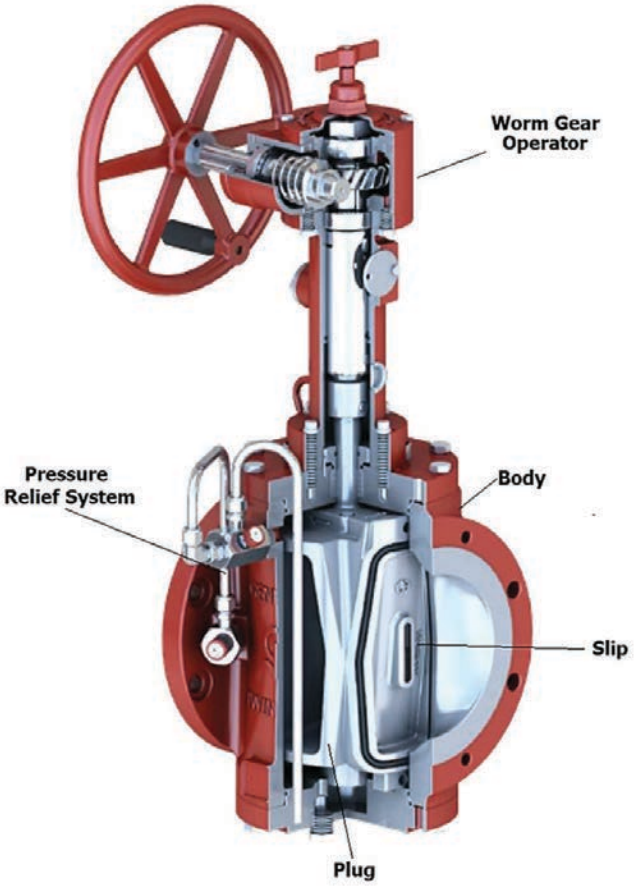
CONS:

- Very difficult to automate. Modifications are needed.
- Not good for throttling service
- Uses a grease sealant (lubricant) for sealing

SERVICES INCLUDE:

- Natural Gas
- Asphalt
- On/Off Service
- Not recommended for other services

TWIN SEAL PLUG VALVE



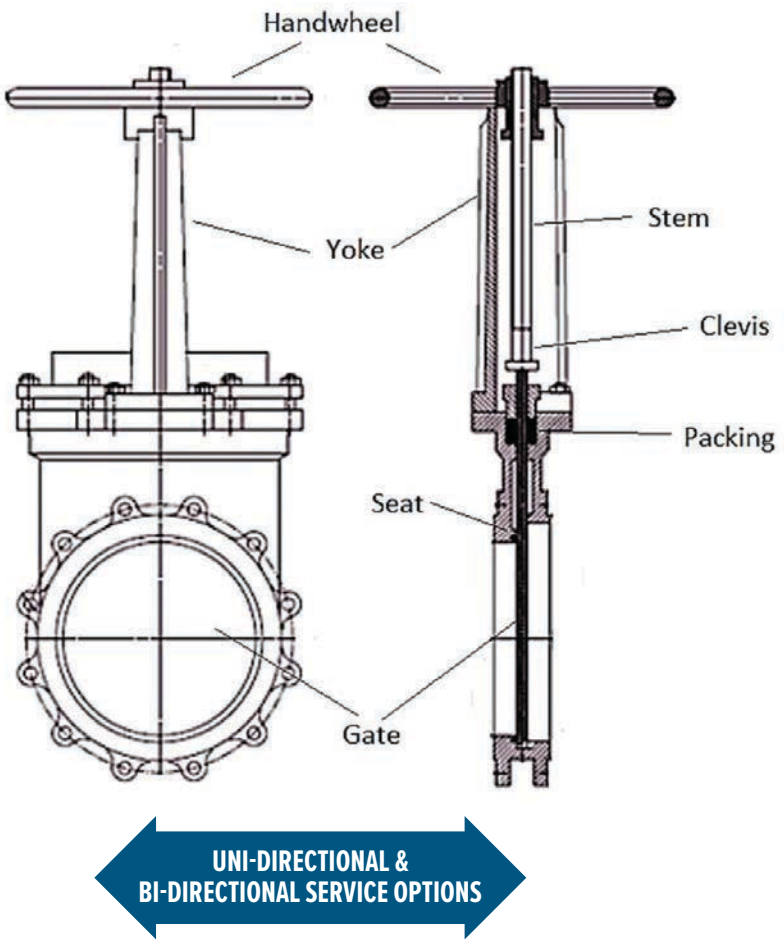
NOTES:

- Plug lifts off seating surface and rotates open
- Extends the life of the seals
- Multi-Turn operation
- Double Block & Bleed
- Pressure Relief System

SERVICES INCLUDE:

- Oil & Gas Meter Stations
- Natural Gas
- Gasoline
- Diesel
- Kerosene
- Jet Fuel
- Tank Storage Isolation

KNIFE GATE VALVE



PROS:

- Typically used in slurry applications
- Metal and Resilient seated options
- Certain designs can be used with high abrasive services
- Many design options for application specific services

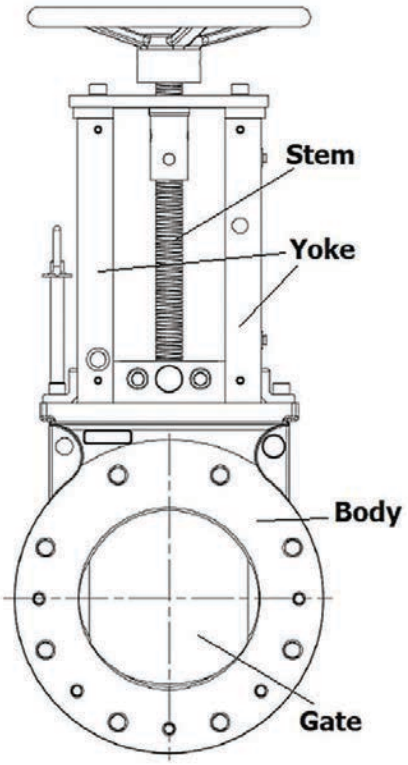
CONS:

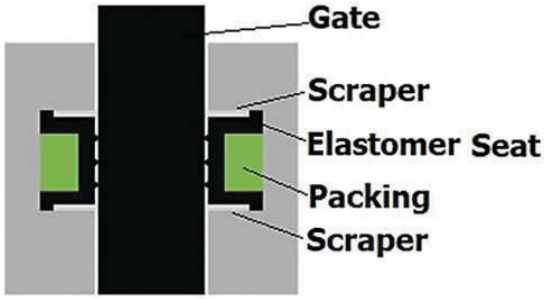
- Multi-Turn = Slow to Open/Close
- More difficult to automate than quarter turn valves
- Shutoff is not as good as Ball or Butterfly Valves

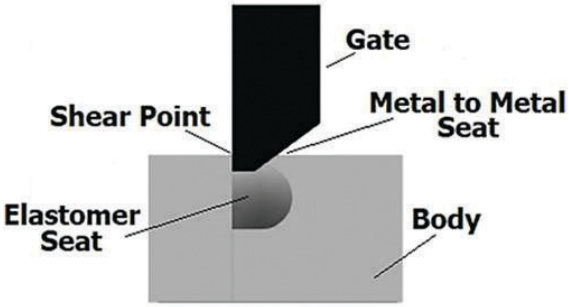
SERVICES INCLUDE:

- Pulp & Paper
- Mining
- Waste Water
- Liquids with particulate (slurries)
- Power (Coal services)

HIGH PERFORMANCE KNIFE GATE VALVE







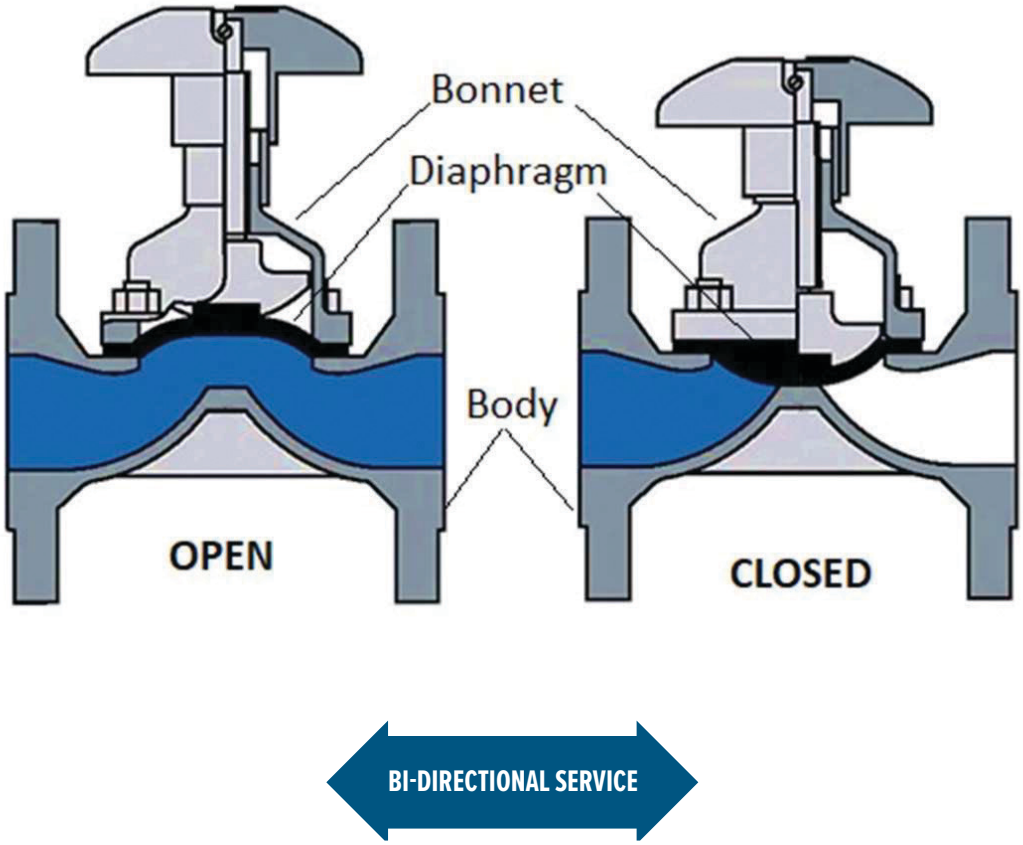
NOTES:

- Heavy Duty Construction ensures long service life
- Bi-Directional Shut-off – 100% Zero Leakage
- The beveled edge gate design allows the knife gate to crush, cut, sever and expel solids that may be in the fluid stream
- No seat cavities where solids can collect and cause gate interference
- Handwheel, Bevel Gear, Pneumatic, Hydraulic and Electric operators available

SERVICES INCLUDE:

- Pulp & Paper – Green, White and Black Liquor
- Power – Fly Ash & FGD
- Mining
- Waste Water & WWTP
- Liquids with particulate (slurries)
- Cement, Sand and Gravel

DIAPHRAGM VALVE (WEIR DESIGN)



PROS:

- Large variety of diaphragm materials
- Easy to Repair
- Lined body option in a variety of materials
- Can be installed in any position
- Factory automatable
- Can be used for On/Off or Modulating

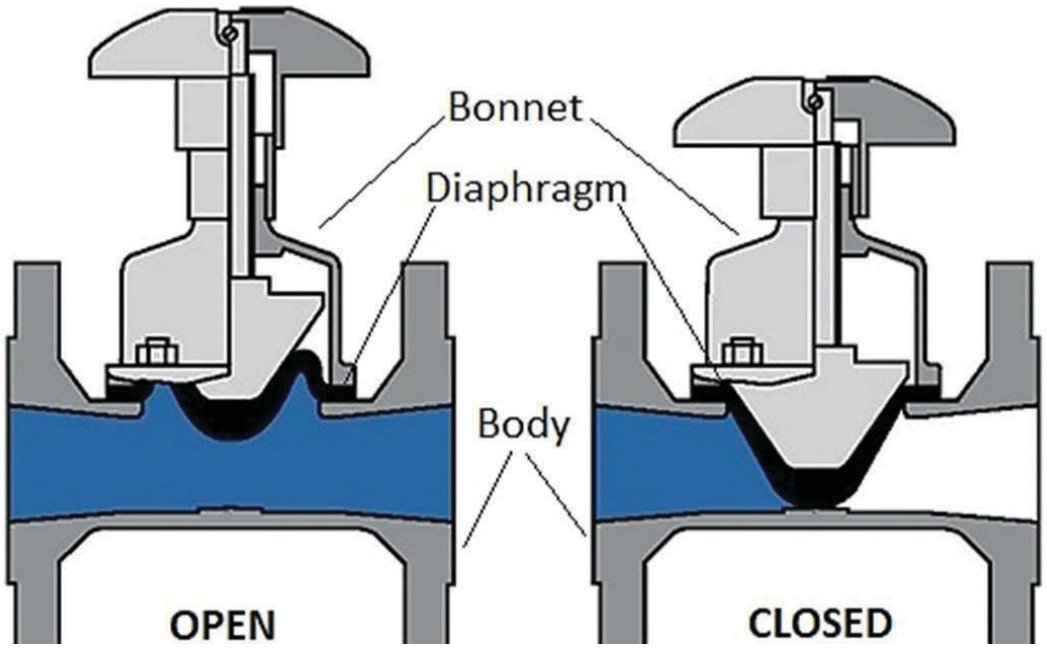
CONS:

- Multi-Turn = Slow to Open/Close
- Do NOT use with solids / slurries
- More expensive that other valve types
- Limited to smaller sizes (16” max)

SERVICES INCLUDE:

- Water
- Clear Liquids
- Acids
- Bases

DIAPHRAGM VALVE (STRAIGHT-THRU DESIGN)



BI-DIRECTIONAL SERVICE

PROS:

- Large variety of diaphragm materials
- Easy to Repair
- Lined body option in a variety of materials
- Can be installed in any position
- Factory automatable
- Very good in abrasive applications

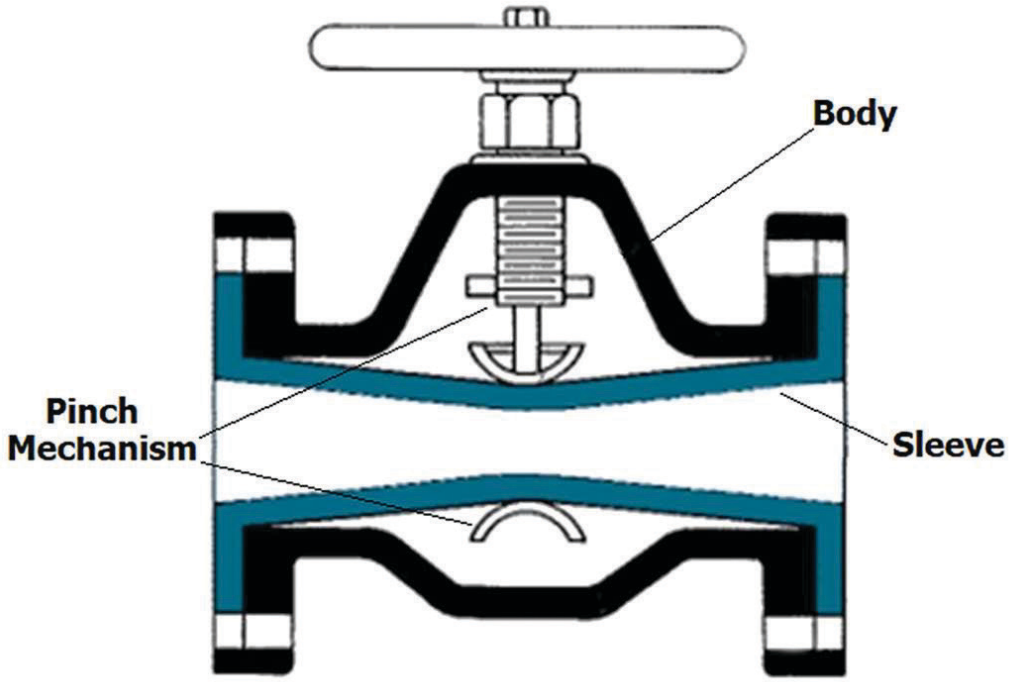
CONS:

- Multi-Turn = Slow to Open/Close
- More expensive that other valve types
- More expensive than Weir Type diaphragm valve – (for slurries, only)
- Typically used for On/Off service, only

SERVICES INCLUDE:

- Water
- Acids
- Bases
- Food Products
- Liquids with particulate (slurries)

PINCH VALVE



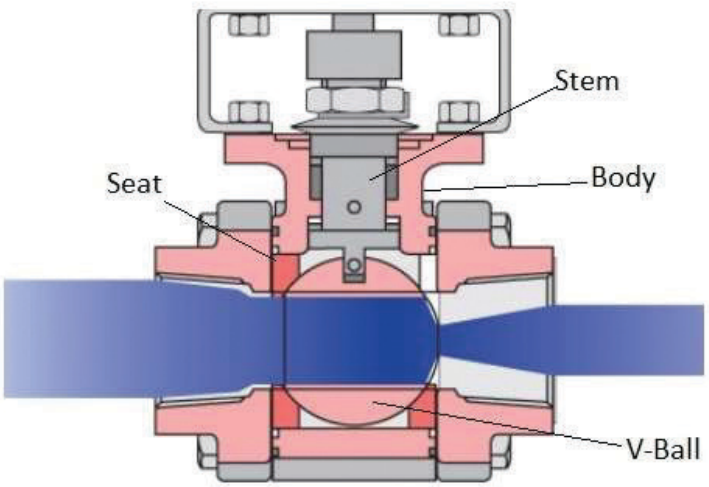
NOTES:

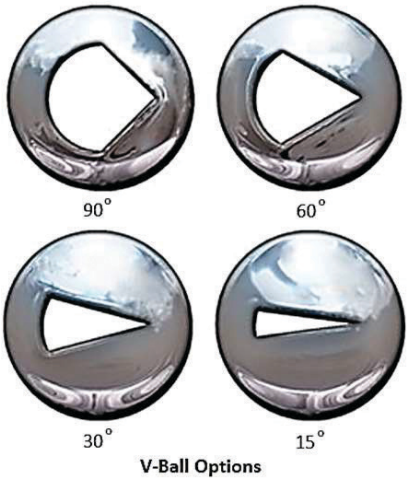
- Bi-Directional Flow
- Multi-Turn operation
- 100 % tight shut-off even with particles in-line
- Only one part to replace (sleeve)
- Field Repairable
- 100% Port Design
- Automation options include: Air operated and Manual, Pneumatic and Electric actuators.
- Factory Automatable
- Control applications available

SERVICES INCLUDE:

- Water and Waste Water
- Slurries
- Abrasive Services
- Mining Service
- Some Corrosive applications

V-PORT BALL VALVE





V-Ball Options

UNI-DIRECTIONAL SERVICE

PROS:

- Characterized Ball Control Valve for Throttling Applications
- Variety of V-Ball Port options
- Quarter Turn operation – Quick open/close
- Easy to Automate
- Commonly used for 2” and smaller valves

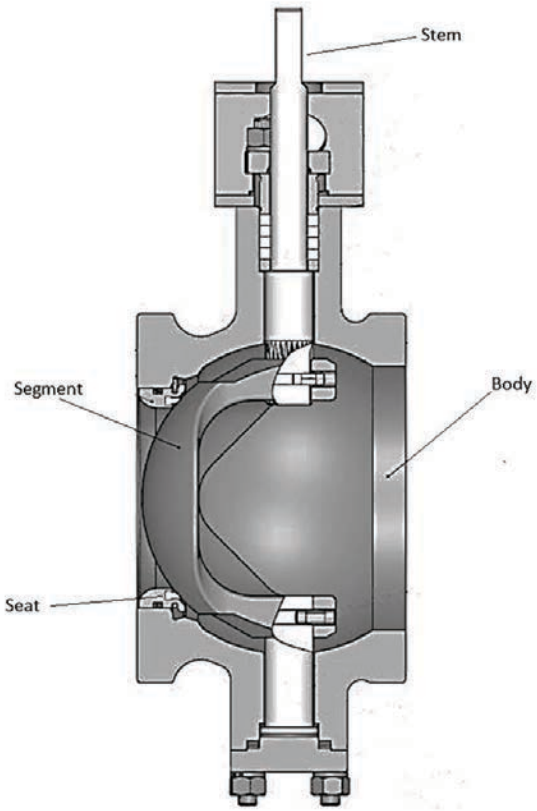
CONS:

- Particulate can still clog the valve

SERVICES INCLUDE:

- Water
- Clear liquids
- Acids / Bases (materials dependent)
- Petroleum Applications
- Throttling Service

SEGMENTED V-BALL VALVE



UNI-DIRECTIONAL SERVICE

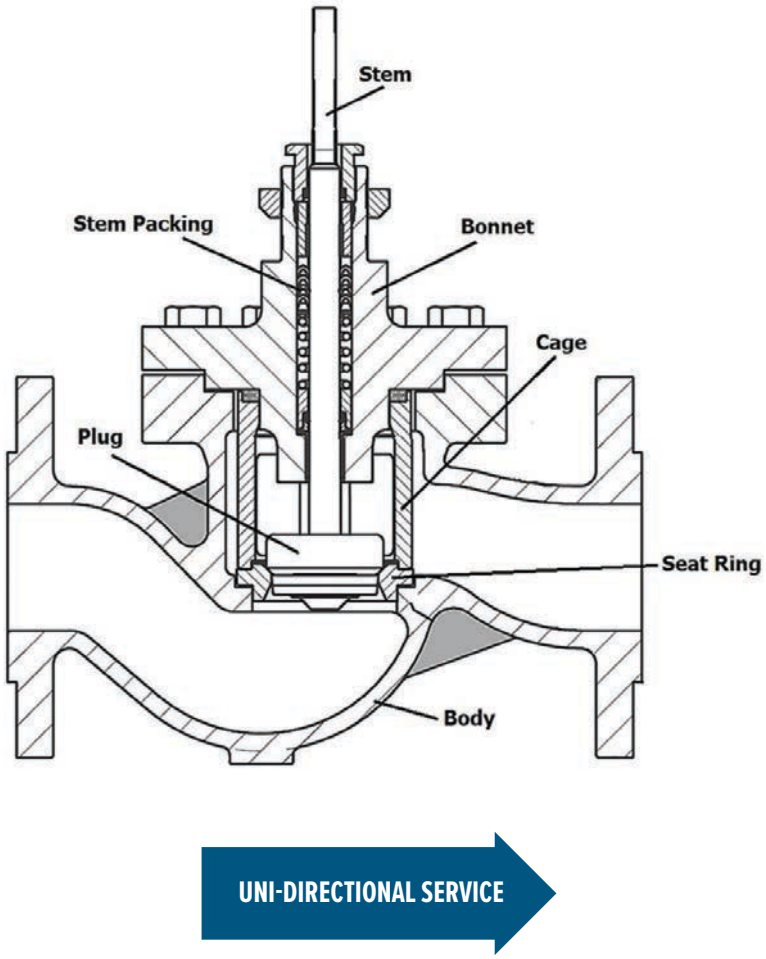
NOTES:

- Great Control Valve for Throttling Applications
- Self cleaning design is good for particulates/slurries
- Quarter Turn operation – Quick open/close
- Easy to Automate
- Metal and Soft Seat options
- Commonly used for 3” and larger valves

SERVICES INCLUDE:

- Water
- Clear liquids
- Acids / Bases (materials dependent)
- Petroleum Applications
- Liquids with particulate (slurries)
- Throttling service

GLOBE STYLE CONTROL VALVE



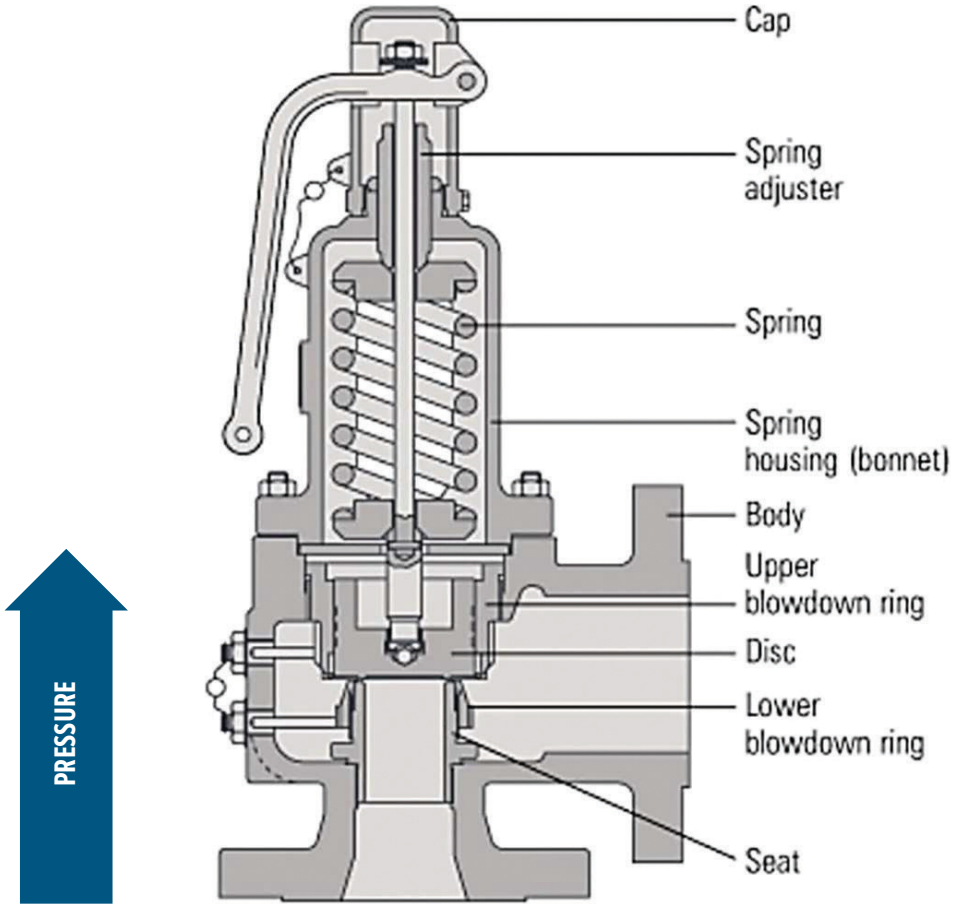
NOTES:

- Used to control liquid services to a fine accuracy
- Various body materials, trim and end connections available
- Equal %, Linear and quick opening plugs
- Three way mixing and diverting options

ACTUATION OPTIONS:

- Pneumatic (spring return & double acting)
- Electric
- Hydraulic
- Positioner (3-15psi and 4-20mA inputs)

SAFETY RELIEF VALVE



NOTES:

- Used to relieve overpressure in liquid, vapor, gas and steam services
- Various designs / materials available
- Valve is dependent on service conditions
- It relieves at a pre-determined “set pressure”

REQUIRED INFORMATION:

- Media?
- Set Pressure?
- Temperature of media?
- Capacity of media (lb/hr, SCFM or GPM)?
- Materials of construction?
- Does the valve have any back pressure?
- ASME Section I or Section VIII (for steam service)

STAMPED

STAMPED is an acronym that can help you remember some basic questions to ask the customer for their applications. Note: This does not answer every question, but it is a good place to start.

Size

Temperature

Application (Media?)

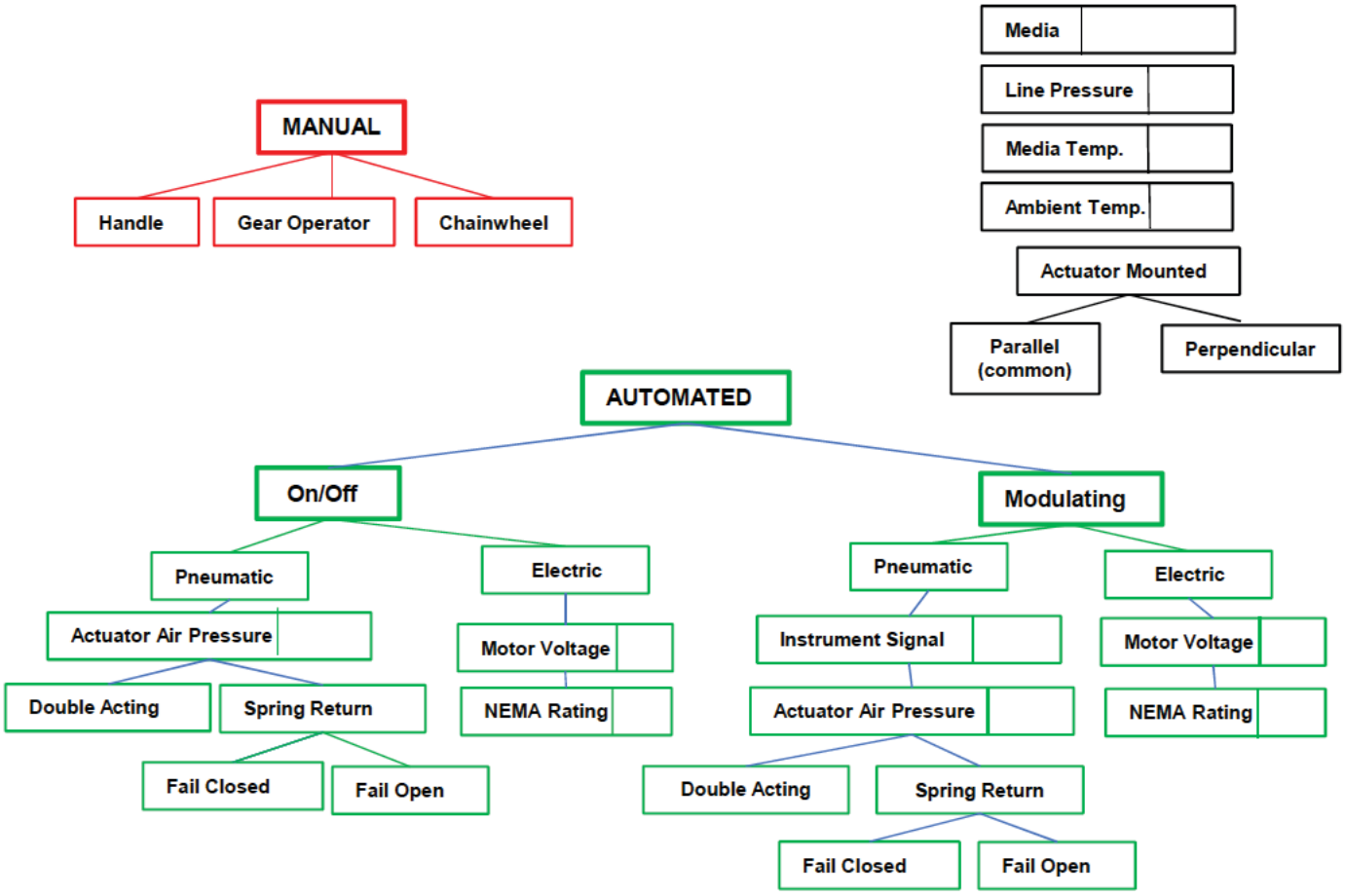
Materials of Construction

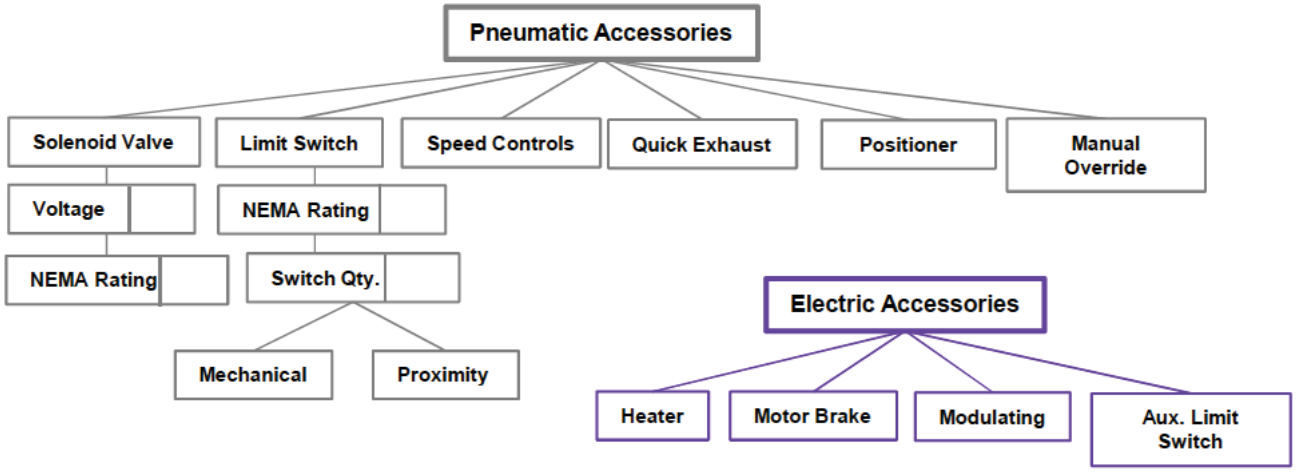
Pressure

End Connections

Delivery Requirements

ACTUATION – HOW TO SPECIFY*





Additional Options or Notes

*For assistance, please contact your local Wolseley Industrial Group at *www.wolseleyindustrialgroup.com/location-finder/*

TORQUE

When trying to determine the appropriate amount of torque required for sizing an actuator/operator, firstly locate the valve manufacturers required torque. This is typically provided in the manufacturers spec sheets or technical bulletin. This value will be presented in inch pounds (in/lbs) or foot pounds (ft/lbs).

Pay special attention to this unit of measurement, as the requested actuator may use a different unit of measurement. Conversion may be required. To convert from inch pounds to foot pounds, divide by 12. To convert from foot pounds to inch pounds, multiply by 12.

Secondly, once the manufacturers torque is confirmed, you may potentially need to add an Application Factor. These factors are used for services that will affect the torque requirement. Review the following chart and multiply your torque by the Application Factor (if your service meets more than one of these, use the highest factor, only).

Thirdly, adding a 20%-30% safety factor* is a good practice. This is adder is used to make sure that the automation that you select will work properly, today, tomorrow and for a long time. Multiply by 1.2 or 1.3.

*Note, some manufacturers publish their required torques with an included safety factor. In this case, the additional safety factor is not required, however, this manufacturer safety factor MUST be listed in their literature to be sure that it is included. If you have any doubt that it is included, add a safety factor.

Application Factor	Mult
Fluids with Solid Particles	1.4
River Water	1.4
Low Temperature 0°F to -150°F	1.3
Cryogenic Service from -150°F and below	2.0
Chlorine Service Cleaned	1.5
Silicone Free (cleaned/bagged for paint service)	1.5
Oxygen Service Cleaned	1.5
Saturated Steam	1.3
Superheated Steam	1.5
Clean Natural and Other Gasses (air, N2)	1.4
Slurries	1.8
Dry Powders	1.8
V-Ball adder	1.3
Cavity Fillers	1.3
Less than one cycle per 6 months	1.4
Less than one cycle per year	1.5
Stem Extensions	2.0

IN REVIEW:

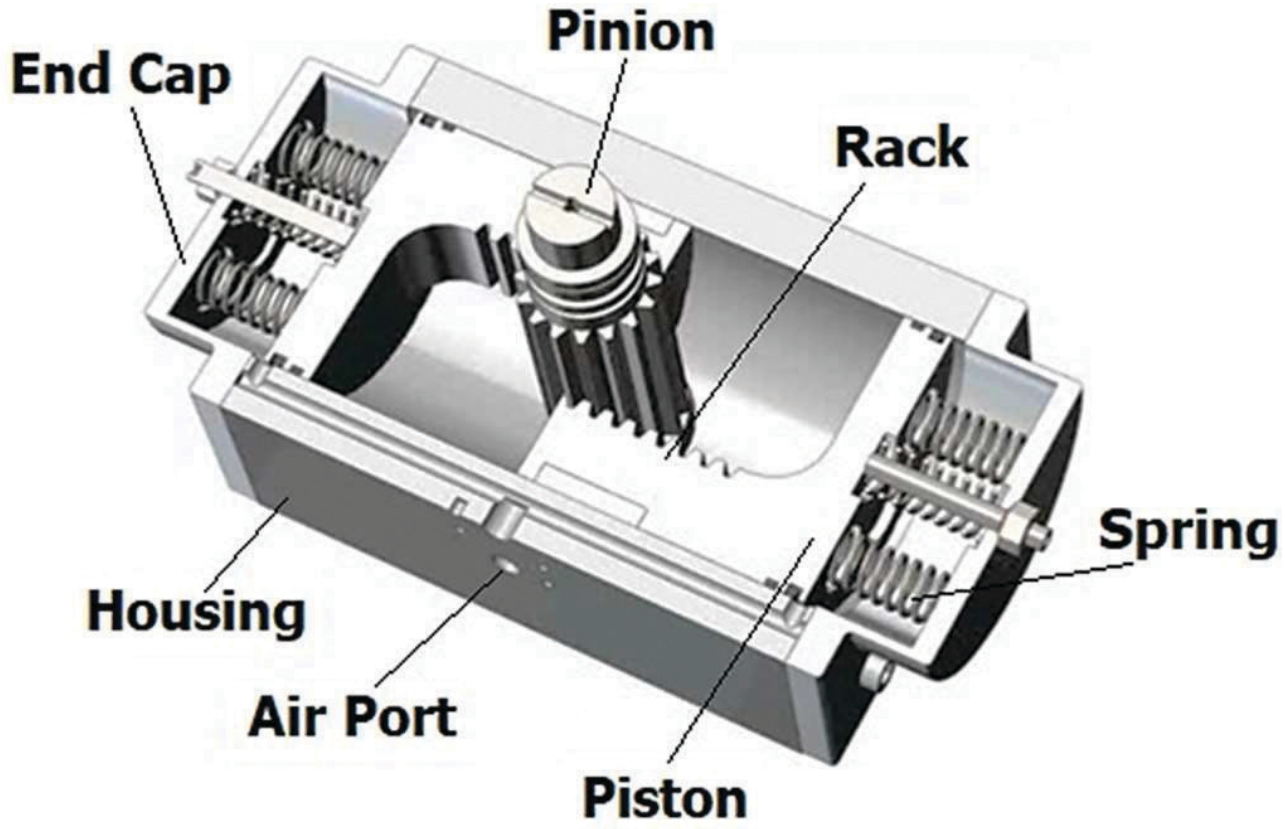
Manufacturers published torque

- add **Application Factor** (if required)
- add **Safety Factor**
- equals **Total required torque**

One final item to consider is the MAST of the valve. MAST is the Maximum Allowable Stem Torque.

If you oversize an actuator for a valve application, the actuator torque may exceed the MAST of the valve. If this occurs, the valve stem can twist beyond repair and even potentially sheer. Typically, this is only a concern if you need to offer a much larger actuator than the service requires, you are working with torque seated valves, or you are using much larger sized valves.

RACK & PINION PNEUMATIC ACTUATOR



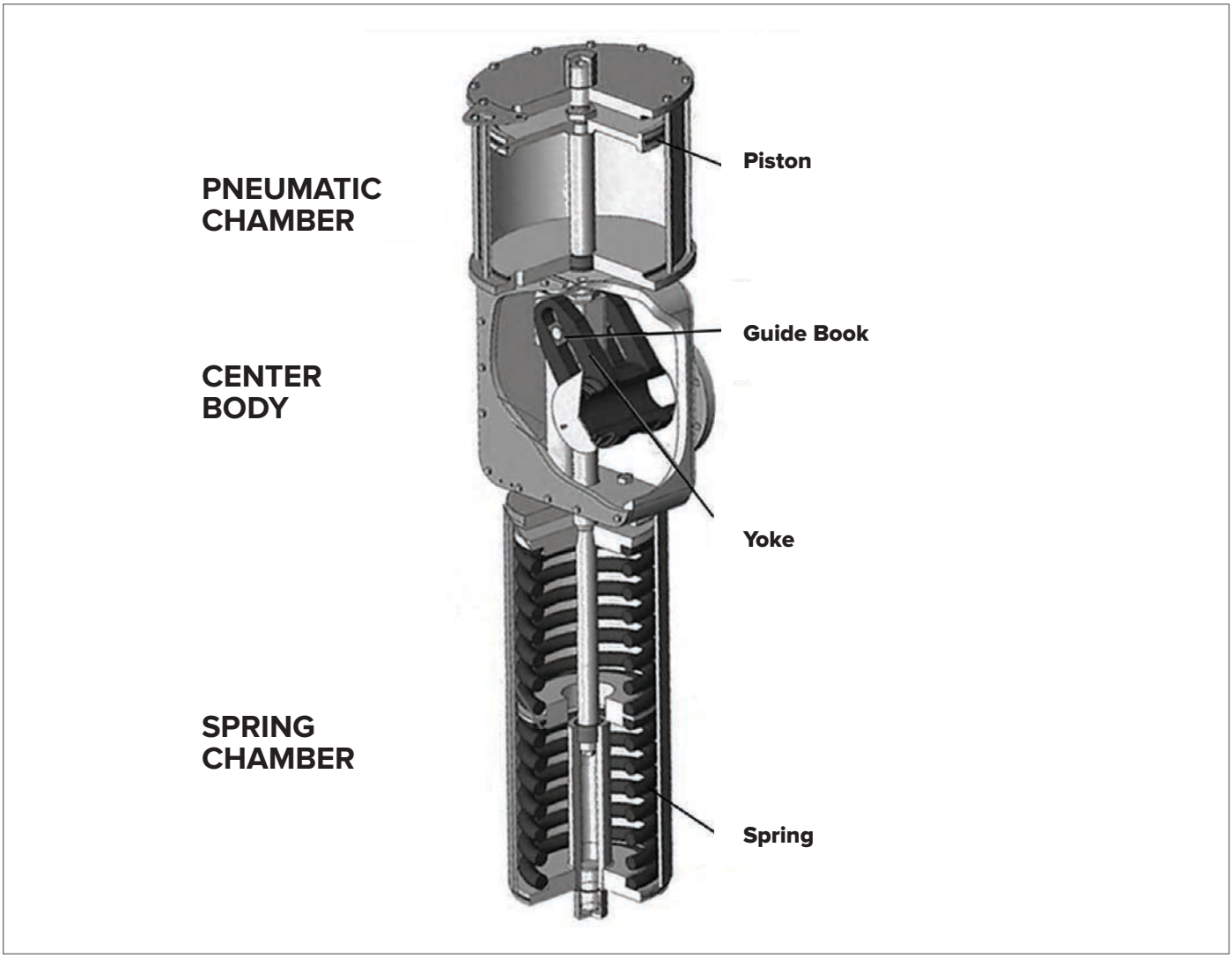
NOTES:

- Used with quarter turn valves (ball, butterfly and plug valves)
- Uses Air / Nitrogen to open operate
- Typically less expensive than Scotch Yoke style actuators
- Double Acting and Spring Return models
- On/Off or Modulating services
- Aluminum housing is standard, but SS and special coatings are available for buried service or corrosion environmental applications
- Some applications allow for direct mounting to the valve. If not, mounting kits are used.

ACTUATION OPTIONS:

- Solenoid
- Limit Switch
- Positioner

SCOTCH YOKE PNEUMATIC ACTUATOR



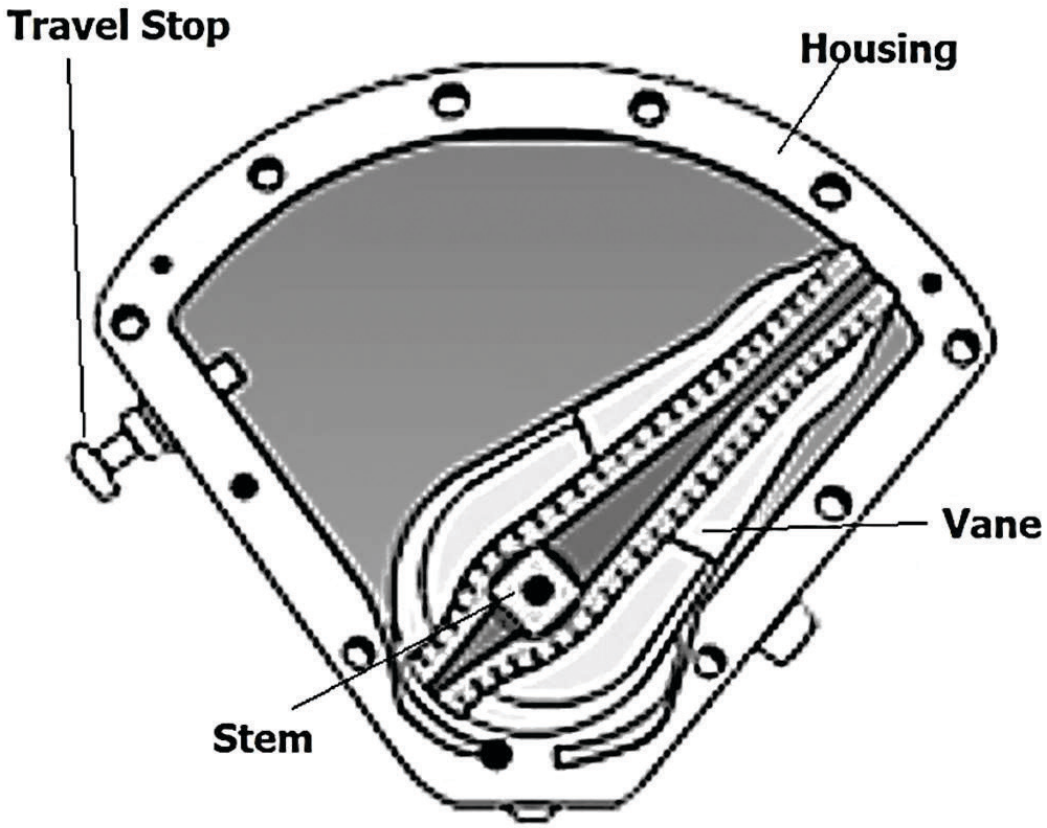
NOTES:

- Commonly used with larger quarter turn valves (ball, butterfly and plug valves)
- Uses Air / Nitrogen to operate
- Typically more expensive than Rack & Pinion style actuators, but available in larger sizes
- Double Acting and Spring Return models
- On/Off or Modulating services
- Modular Design to maximize flexibility
- Available with standard or canted yoke, depending on Break Torque requirements

ACTUATION OPTIONS:

- Hydraulic Option
- Solenoid
- Limit Switch
- Positioner
- Jackscrew Override

VANE STYLE PNEUMATIC ACTUATOR



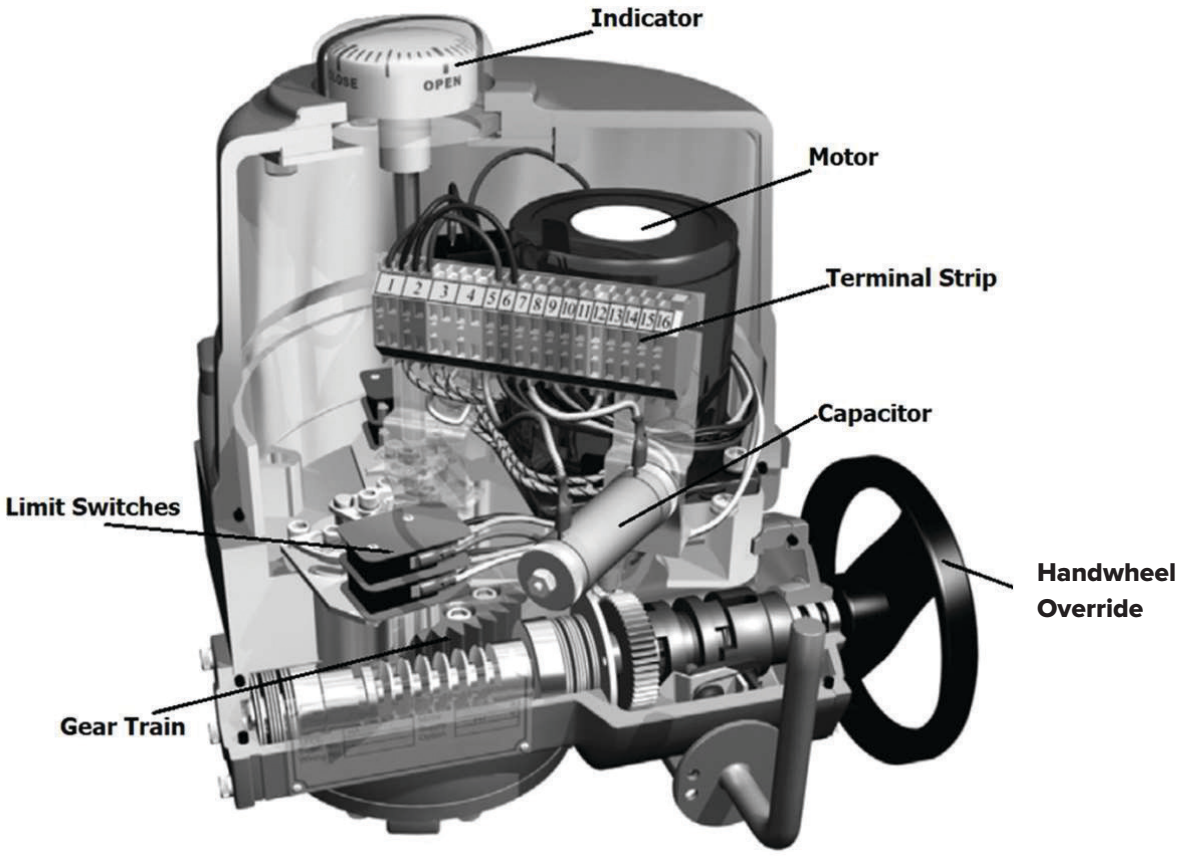
NOTES:

- Uses Air / Nitrogen to open and close quarter turn valves
- One moving part (vane)
- High Cycle – Long Life Design
- Double Acting and Fail Safe options
- On/Off or Modulating services
- Reverse acting by flipping the actuator over

ACTUATION OPTIONS:

- Solenoid
- Limit Switch
- Positioner

ELECTRIC ACTUATOR



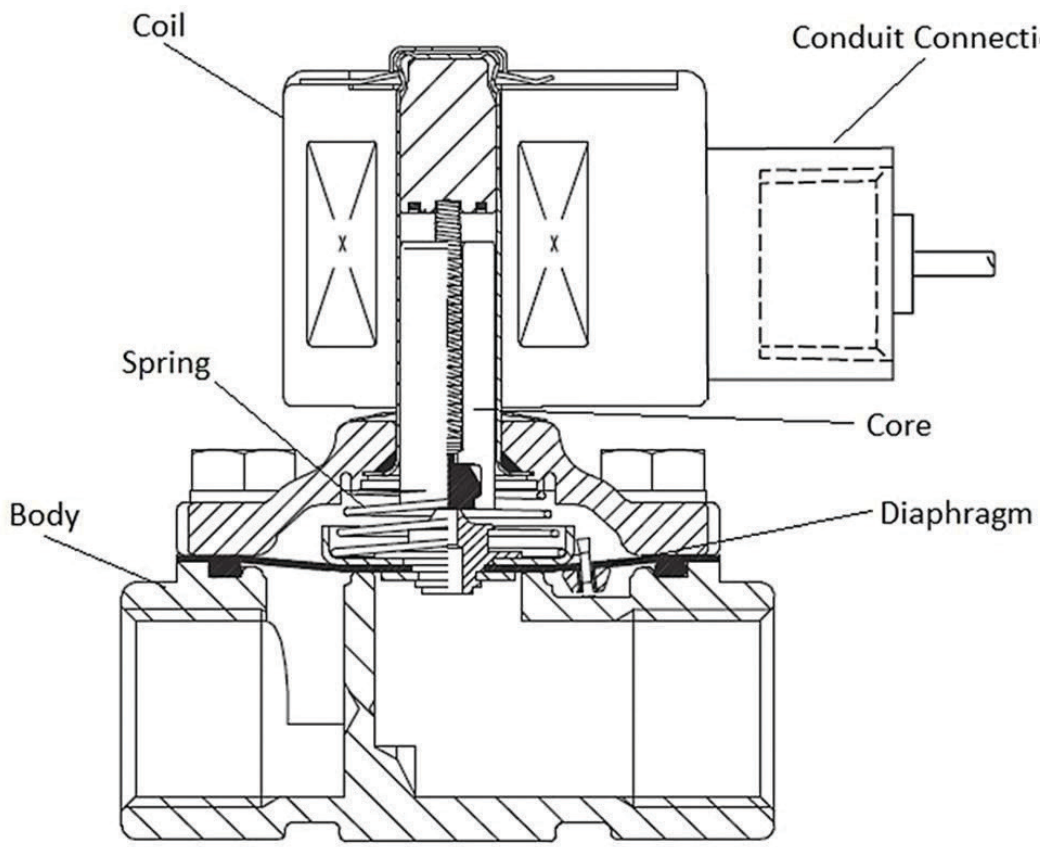
NOTES:

- Uses electric voltage to open and close quarter turn valves
- 120vac is the most common voltage
- Others voltages include 24vdc, 24vac, 12vdc, 220vac/1ph, 220vac/3ph, 480v/3ph and many more.
- Available in either watertight (Nema 4) or watertight/explosionproof (Nema 4&7) rated housings
- Available in on/off and modulating (4-20mA)
- Standard units fail in place on loss of power, but fail closed units are available (expensive)

ACTUATION OPTIONS:

- Auxiliary limit switches
- Motor Brake (for butterfly valves)
- Anti-condensation heater/ thermostat
- Feedback/Retransmission (4-20mA)
- Speed Control/Cycle Timer
- Local Control Station
- Torque Switches
- Back Up Power Supply

2 WAY SOLENOID VALVE



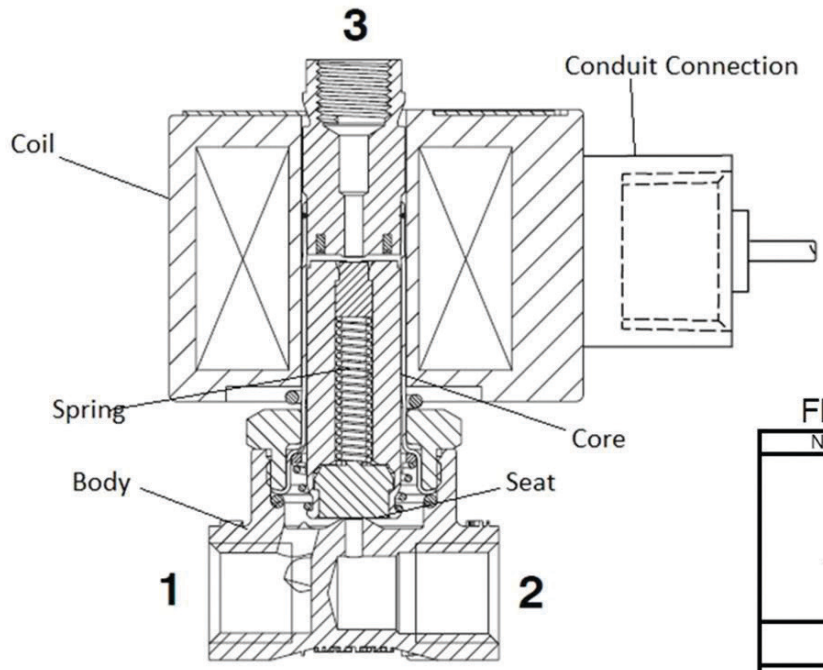
NOTES:

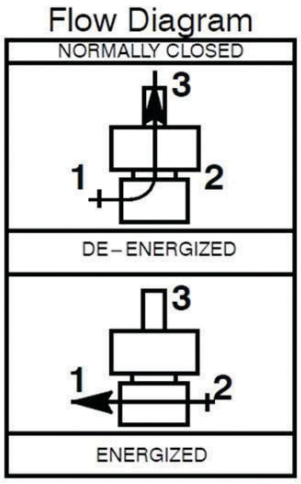
- Used to control flow in-line
- Brass and SS bodies available
- Typically limited to 3” size and less
- Unidirectional flow design
- Used in air, gas, steam and oil applications
- Do not use in slurries/particulate applications

SERVICES INCLUDE:

- Water
- Clear Liquids
- Acids (material dependent)
- Bases (material dependent)
- Oils
- Air / Nitrogen
- Oxygen and other gases
- Steam

3-WAY SOLENOID VALVE





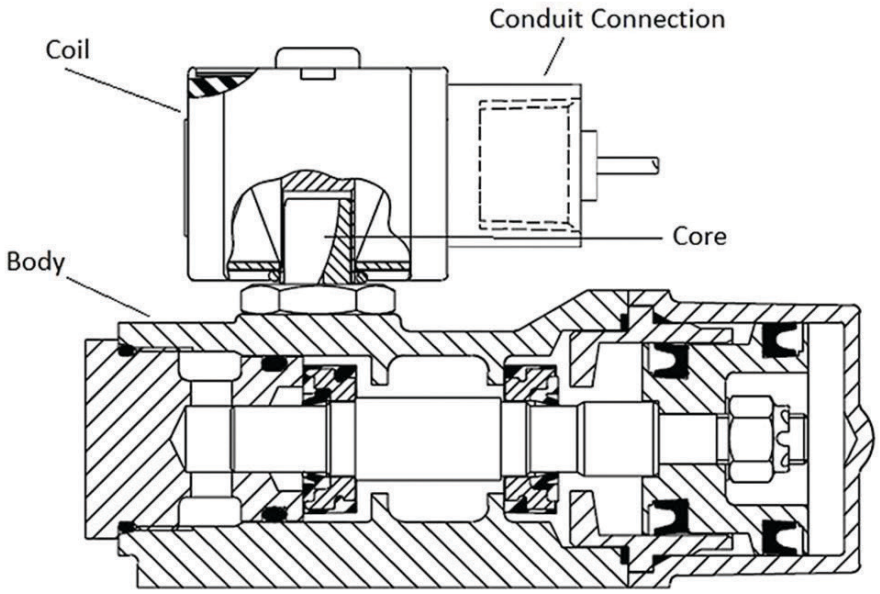
NOTES:

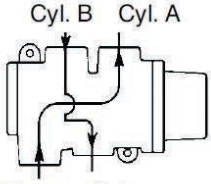
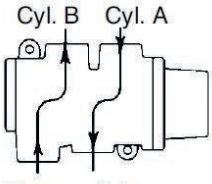
- Used to control spring return pneumatic actuators
- Nipple mounted and NAMUR mounted options
- Brass, SS and Aluminum bodies available
- Do not use in in Dirty Air service

SERVICES INCLUDE:

- Compressed Air
- Nitrogen

4-WAY SOLENOID VALVE



FLOW DIAGRAM for Single Solenoid	
De–Energized	Energized
	

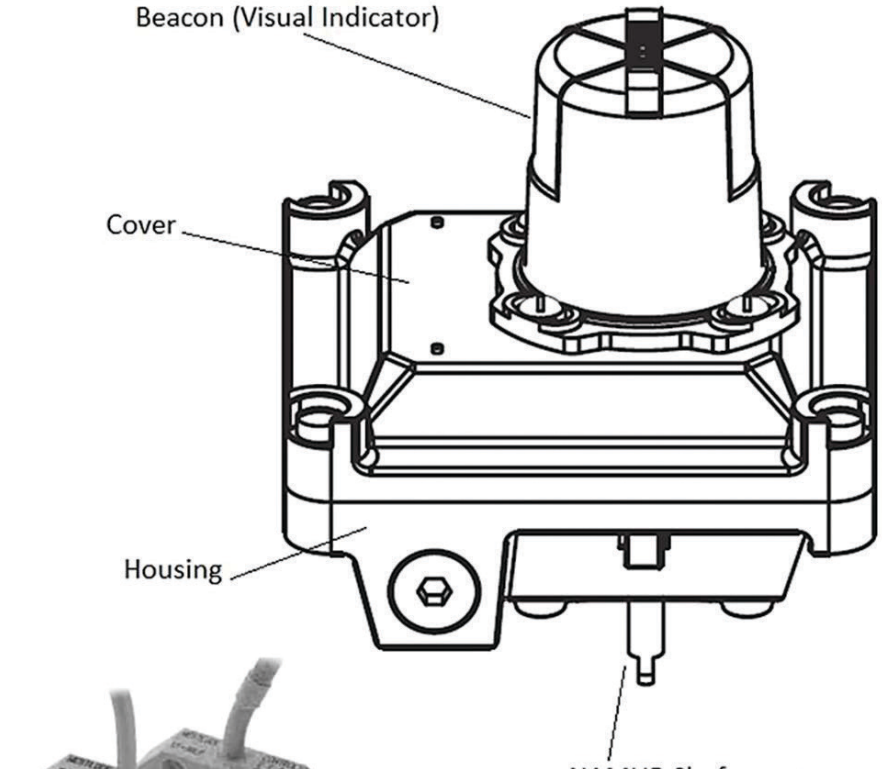
NOTES:

- Used to control double acting pneumatic actuators (can also be used is SR acts)
- Nipple mounted and NAMUR mounted options
- Brass, SS and Aluminum bodies available
- Dual coil models available for fail in last (FIP) applications
- Do not use in in Dirty Air service

SERVICES INCLUDE:

- Compressed Air
- Nitrogen

LIMIT SWITCH



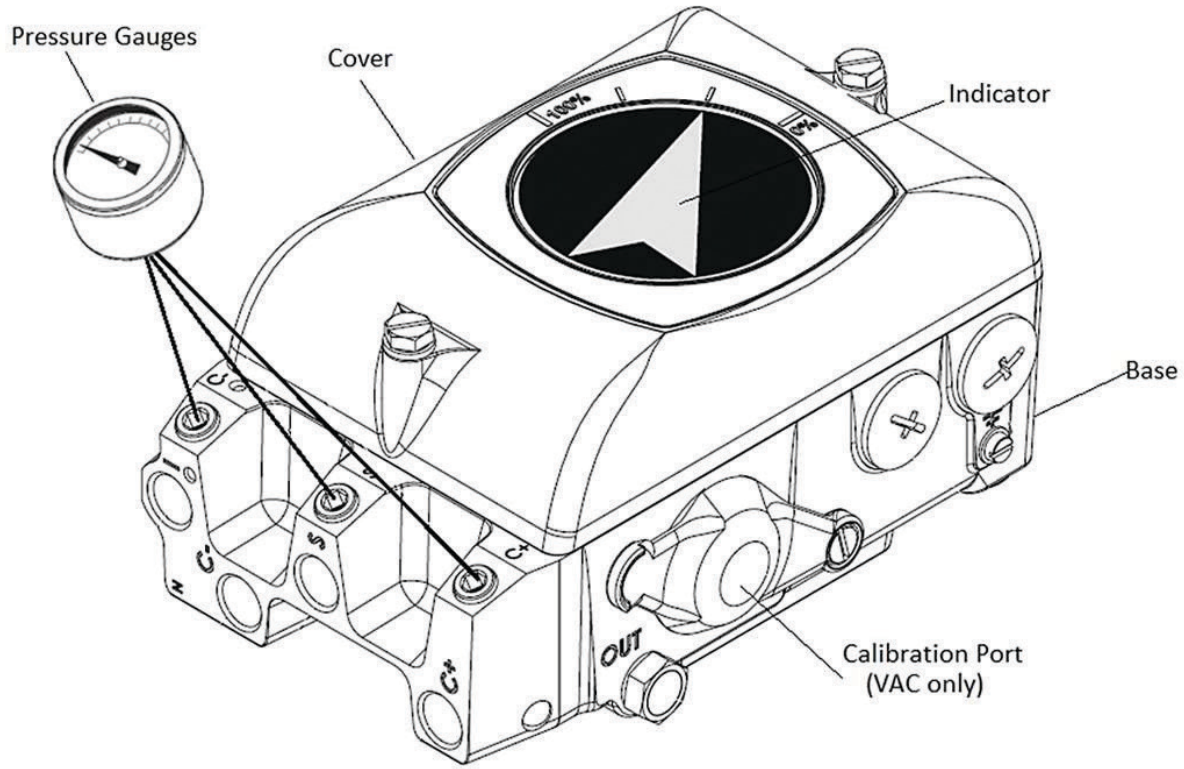
Proximity Switch

Mechanical Switch

NOTES:

- Used on pneumatic actuators to confirm position feedback
- Most come with a visual indicator for local indication
- A variety of switch quantity and designs available
- Can be mounted on gear operators and handle operated valves
- Mechanical and Proximity switch types
- Typically includes two switches, but other quantities are available
- Water Tight and Explosion Proof designs
- Feedback Potentiometer option
- Different visual indicator styles/colors

POSITIONER



NOTES:

- Used on pneumatic actuators to throttle the valve package
- 4-20mA or 3-15psi control signal options (others available)
- Most come with a visual indicator for local indication
- Optional Mechanical and Proximity switches
- Water Tight and Explosion Proof designs
- 4-20mA Feedback option
- Different visual indicator styles/colors
- Smart (Digital) type positioners are available with HART communication

ISO 5211 REFERENCE

Flange Type	Metric Bolt Circle	Imperial Bolt Circle	Qty of Bolts
F03	36mm	1.42"	4
F04	42mm	1.65"	4
F05	50mm	1.97"	4
F07	70mm	2.76"	4
F10	102mm	4.02"	4
F12	125mm	4.92"	4
F14	140mm	5.51"	4
F16	165mm	6.50"	4
F25	254mm	10.00"	8
F30	298mm	11.73"	8
F35	356mm	14.02"	8
F40	406mm	15.98"	8

Female Sq. Drive - Metric	Female Sq. Drive - Imperial
9mm	0.35"
11mm	0.43"
14mm	0.55"
17mm	0.67"
22mm	0.87"
27mm	1.06"
36mm	1.41"
46mm	1.81"
55mm	2.17"
75mm	2.95"

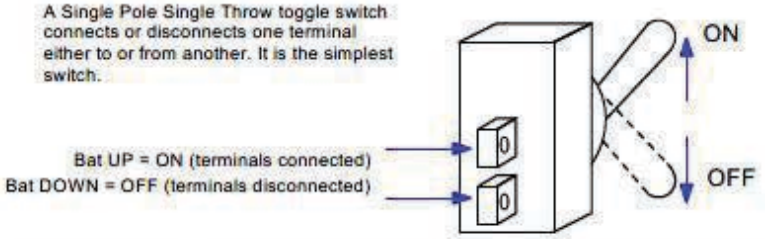
Convert mm to inches = divide by 25.4

Convert Inches to mm = mult by 25.4

SWITCHES DEMYSTIFIED

SPST

A Single Pole Single Throw toggle switch connects or disconnects one terminal either to or from another. It is the simplest switch.

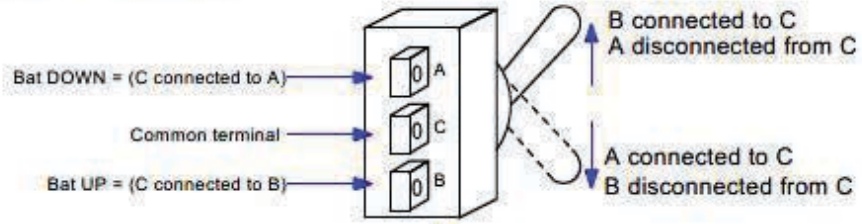


SPST Schematic Symbol

SPDT

A Single Pole Double Throw toggle switch connects a common terminal to one or the other of two terminals. It is always connected to one or the other. The two outside terminals are never connected by the switch.

To use a SPDT switch as a SPST switch just use the common terminal and either of the other terminals. So... you could use C and A or you could use C and B.

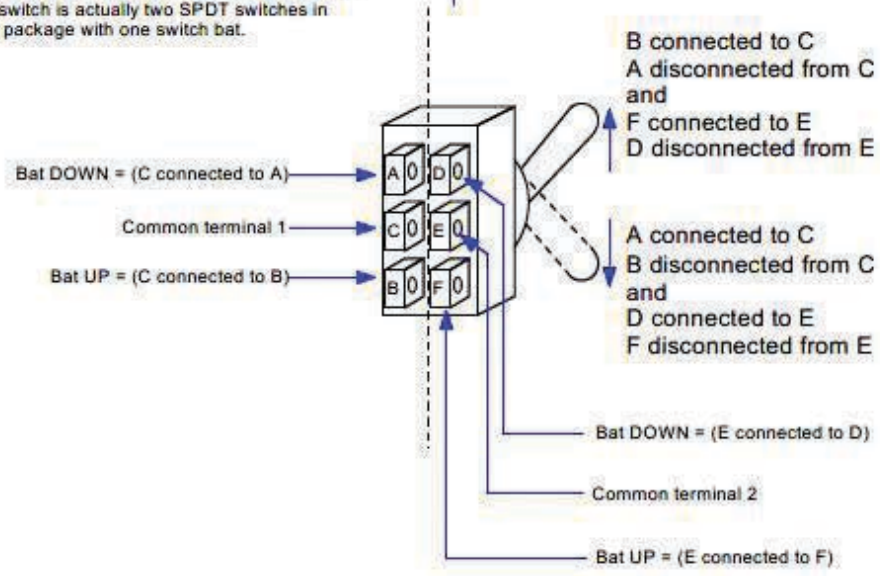


SPDT Schematic Symbol

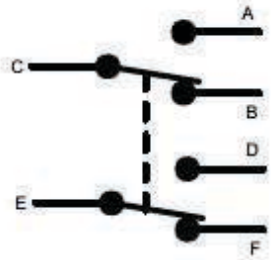
DPDT

A Double Pole Double Throw toggle switch acts exactly like two separate SPDT switches connected to the same switch bat. It has two separate common terminals and each of those is connected to one or the other of the other two terminals on the same side of the switch. The dotted line in the picture is to illustrate that the switch is actually two SPDT switches in one package with one switch bat.

A DPDT switch works just like two separate SPDT switches attached to the same switch bat.



DPDT Schematic Symbol



NEMA RATINGS

NEMA 4

Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, snow, windblown dust, splashing water, and hose-directed water; and that will be undamaged by the external formation of ice on the enclosure (Watertight).

NEMA 4X

Same as NEMA 4 including protection against corrosion.

NEMA 6

Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against hose-directed water and the entry of water during occasional temporary submersion at a limited depth; and that will be undamaged by the external formation of ice on the enclosure.

NEMA 7

Enclosures are for indoor use in locations classified as Class I, Groups A, B, C, or D and shall be capable of withstanding the pressures resulting from an internal explosion of specified gases, and contain such an explosion sufficiently that an explosive gas-air mixture existing in the atmosphere surrounding the enclosure will not be ignited. Enclosed heat generating devices shall not cause external surfaces to reach temperatures capable of igniting explosive gas-air mixtures in the surrounding atmosphere. Enclosures shall meet explosion, hydro-static, and temperature design tests.

NEMA 9

Enclosures are intended for indoor use in locations classified as Class II, Groups E, F, or G, and shall be capable of preventing the entrance of dust. Enclosed heat generating devices shall not cause external surfaces to reach temperatures capable of igniting or discoloring dust on the enclosure or igniting dust-air mixtures in the surrounding atmosphere. Enclosures shall meet dust penetration and temperature design tests, and aging of gaskets (if used).

CLASS / DIV / GROUP EXPLAINED

DIVISION 1

Constant or Occasional Hazard

The substance referred to by class hasa high probability of producing an explosive or ignitable mixture due to it being present continuously, intermittently, or periodically or from the equipment itself under normal operating conditions.

DIVISION 2

Temporary or Rare Hazard

The substance referred to by class has a low probability of producing an explosive or ignitable mixture and is present only during abnormal conditions for a short period of time, such as a container failure or system breakdown.

Classes and Groups According to NEC 500

Typical Types of Media	Class	Group
Acetylene	Class I	Group A
Hydrogen	Class I	Group B
Ethylene	Class I	Group C
Propane / Methane / Gasoline	Class I	Group D
Metal Dust	Class II	Group E
Coal Dust (Charcoal)	Class II	Group F
Particle Dust (Flour / Grain)	Class II	Group G
Fibers / Lint	Class III	

NON-INCENDIVE

Non-Incendive components are at any energy level too low to cause ignition (non-sparking) and surface temperatures are not are above the temperature class under normal conditions

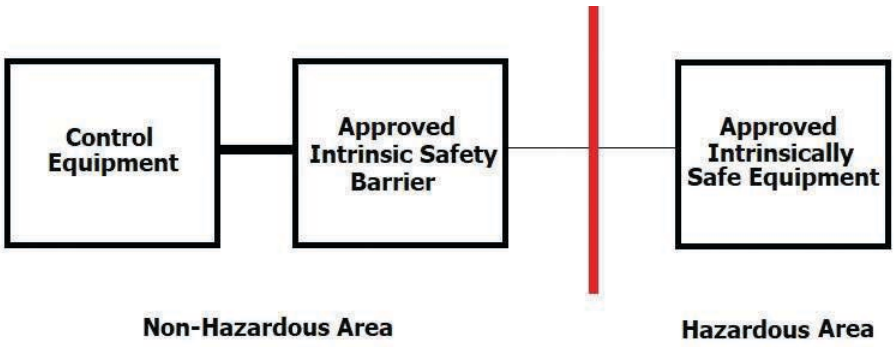
Equipment certified using this protection method is suitable for use in Class I, II, III Division 2.

“No Spark Means No Boom!”

INTRINSICALLY SAFE

“Intrinsically Safe” is used to describe any product designed using intrinsically safe circuits. An intrinsically safe circuit in which any thermal effect, produced either normally or in specified fault conditions, is incapable of causing ignition of a mixture of flammable or combustible material in air in the mixture’s most easily ignited concentration. Meaning that the system prevents sparks and keeps temperatures low.

In simple terms this means that intrinsically safe equipment and wiring will limit electrical and thermal energy to a level below what required to cause start an explosion. Intrinsically safe equipment operates on low power levels. Safety barriers are grounded to be effective under fault conditions and intrinsic safety is provided through voltage and current limiters.



EXPLOSION PROOF

Explosion proof, according to the National Electrical Code, applies to an apparatus enclosed in a case that is capable of withstanding a gas or vapor explosion. It means that, should there be an explosion, it will be contained within an enclosure. This containment is done through careful design of the enclosure so that the resulting energy is not only contained; it is also dissipated through the large surface of the flanges or threads of the enclosure. The net result is that Explosion Proof protection has a higher level of required maintenance than an Intrinsically Safe system.

Therefore, Intrinsically Safe means that an apparatus, such as a solenoid valve coil is not capable of causing an explosion. Explosion Proof means that should an explosion occur, it will be contained within an enclosure.

COMMON TESTING/DESIGN STANDARDS

API RP 591 Process Valve Qualification Procedure
API RP 591 is a recommended practice (RP) which provides guidance for evaluation of manufacturer's valve construction and quality management system. The purpose is to provide interested parties testing procedures and acceptance criteria for evaluation a manufacturer's valves.

API Std 594, Check Valves: Flanged, Lug, Wafer, and Butt Welding
API 594 Specifies the requirements for design, material, face-to-face dimensions, pressure/temperature ratings, and examination, inspection, and test requirements for type "A" and type "B" check valves. Type "A"

Check Valves are short face-to-face, and can be wafer, lug, or double flanged, single plate or dual plate. Type "B" bolted-cover swing check valves are long face-to-face, and can be flanged or butt-welding ends of steel, nickel alloy, or other alloy material.

API 598 – Valve Inspection & Testing
API 598 details all the testing and inspection requirements for gate, globe, plug, ball, check and butterfly valves. ASME/ANSI B16.34 determine the test pressures required for API598.

API 6D Specification for Pipeline Valves - Plug, Gate, Ball and Check
API 6D is the standard used for valves in pipeline service. API 6D has more stringent testing requirements compared to the API 600, 602, 608, or 609 design criteria.

API 600 – Cast Steel Valves – Heavy Wall Design/Construction
API 600 is the primary steel gate valve purchase specification. API 600 details valve design/construction criteria as well as material/trim designations. ISO 10434 is a similar spec published in the ISO format.

API 602 – Forged Steel Gate Valves-Flanged, Threaded, Welding and Extended-Body Ends
API 602 is for 4" and smaller forged steel valves. Like API600 the spec details valve design/construction criteria as well as material/trim designations.

API 603 – Cast Steel Valves – Light Wall Design/Construction
API 603 valves range through ½" to 24" in ANSI 150, 300 and 600. API 603 is for thin walled applications where the thicker API 600 is not required

API 607 Fire Test for Quarter-Turn Valves and Valves Equipped with Nonmetallic Seats and Metallic Seats
API 607 is a fire test for soft-seated and metal seated quarter turn valves; the standard covers testing and performance requirements for valves exposed to certain fire conditions defined in the standard

COMMON TESTING/DESIGN STANDARDS

API 608 – Metal Seated and Soft Seated Ball Valves – Flanged and Butt-Welding (BW) Ends, SW and Threaded Ends
API 608 is the purchase specification for class 150, 300 and 600 flanged and BW ball valve and class 800 BW,SW, and Threaded ball valves. Design and construction criteria are detailed in this spec.

API 622 Type Testing of Process Valve Packing for Fugitive Emissions
API 622 is a performance test which runs a span of 1,510 mechanical cycles at 600 psig operating pressure over 5 thermal cycles. Leakage measurements of the test gas, methane, are taken periodically throughout the test.

API 623 – Steel Globe Valves – Flanged and BW Ends, Bolted Bonnets
API 623 standard specifies the requirements for a heavy-duty series of bolted bonnet steel globe valves for the petroleum refinery and related applications where corrosion, erosion and other service conditions would indicate a need for heavy wall sections and large stem diameters.

API 624 Type Testing of Rising Stem Valves Equipped with Flexible Graphite Packing for Fugitive Emissions standard.
API 624 standard specifies the requirements and acceptance criteria (100 ppmv) for fugitive emissions type testing of rising and rising-rotating stem valves equipped with packing previously tested in accordance with API Standard 622. The fugitive emissions testing includes 310 mechanical cycles with three thermal cycles – ambient to 500° F.

API 641 Type Testing of Quarter-turn Valve for Fugitive Emissions
This standard specifies the requirements and acceptance criteria for fugitive emission type testing of quarter-turn valves.

ASME & NACE® STANDARDS

ASME (AMERICAN SOCIETY FOR MECHANICAL ENGINEERING)

B16.10 - Face-to-face and end-to-end dimension of valve

B16.11 - Forged fitting socket-welding and threaded

B16.25 - Butt welding ends

B16.34 - Valves: flanged, threaded and welding ends

B16.5 - Pipe flanges and flanged fittings

NACE® (NATIONAL ASSOCIATION OF CORROSION ENGINEERS)

MR0103: Material Resistant to sulfide stress cracking in corrosive petroleum refining.

MR0175: Materials for use in Hydrogen Sulfide, containing environments in oil and gas production.

API TRIM CHART

energy API

API Trim #	Material	Seat	Disc	Backseat	Stem	Notes
1	410	410	410	410	410	-
2	304	304	304	304	304	-
3	F310	310	310	310	310	-
4	Hard 410	Hard 410	Hard 410	410	410	Seats 750 BHN min.
5	Hardfaced	Stellite	Stellite	410	410	-
5A	Hardfaced	Ni-Cr	Ni-Cr	410	410	-
6	410 and Cu-Ni	Cu-Ni	Cu-Ni	410	410	-
7	410 and Hard 410	Hard 410	Hard 410	410	410	Seats 750 BHN min.
8	410 and Hardfaced	Stellite	410	410	410	-
8A	410 and Hardfaced	Ni-Cr	410	410	410	-
9	Monel	Monel	Monel	Monel	Monel	-
10	316	316	316	316	316	-
11	Monel and Hardfaced	Stellite	Monel	Monel	Monel	-
12	316 and Hardfaced	Stellite	316	316	316	-
13	Alloy 20	Alloy 20	Alloy 20	Alloy 20	Alloy 20	-
14	Alloy 20 and Hardfaced	Stellite	Alloy 20	Alloy 20	Alloy 20	-
15	304 and Hardfaced	Stellite	Stellite	304	304	-
16	316 and Hardfaced	Stellite	Stellite	316	316	-
17	347 and Hardfaced	Stellite	Stellite	347	347	-
18	Alloy 20 and Hardfaced	Stellite	Stellite	Alloy 20	Alloy 20	-

CLASS PRESSURE & TEMPERATURE CHART

A105 CS MATERIAL

Temperature °F	150	300	400	600	800	900	1500	2500	4500
-20 to 100	285	740	990	1,480	1,975	2,220	3,705	6,170	11,110
200	260	675	900	1,350	1,800	2,025	3,375	5,625	10,120
300	230	655	875	1,315	1,750	1,970	3,280	5,470	9,845
400	200	635	845	1,270	1,690	1,900	3,170	5,280	9,505
500	170	600	800	1,200	1,595	1,795	2,995	4,990	8,980
600	140	550	730	1,095	1,460	1,640	2,735	4,560	8,210
650	125	535	715	1,075	1,430	1,610	2,685	4,475	8,055
700	110	535	710	1,065	1,420	1,600	2,665	4,440	7,990
750	95	505	670	1,010	1,345	1,510	2,520	4,200	7,560
800	80	410	550	825	1,100	1,235	2,060	3,430	6,170
850	65	270	355	535	715	805	1,340	2,230	4,010
900	50	170	230	345	460	515	860	1,430	2,570
950	35	105	140	205	275	310	515	860	1,545
1000	20	50	70	105	140	155	260	430	770

CLASS PRESSURE & TEMPERATURE CHART

316SS MATERIAL

Temperature °F	150	300	400	600	800	900	1500	2500	4500
-20 to 100	275	720	960	1,440	1,920	2,160	3,600	6,000	10,800
200	235	620	825	1,240	1,655	1,860	3,095	5,160	9,290
300	215	560	745	1,120	1,495	1,680	2,795	4,660	8,390
400	195	515	685	1,025	1,370	1,540	2,570	4,280	7,705
500	170	480	635	955	1,275	1,435	2,390	3,980	7,165
600	140	450	600	900	1,205	1,355	2,255	3,760	6,770
650	125	445	590	890	1,185	1,330	2,220	3,700	6,660
700	110	430	580	870	1,150	1,305	2,170	3,620	6,515
750	95	425	570	855	1,130	1,280	2,135	3,560	6,410
800	80	420	565	845	1,105	1,265	2,110	3,520	6,335
850	65	420	555	835	1,080	1,255	2,090	3,480	6,265
900	50	415	555	830	1,050	1,245	2,075	3,460	6,230
950	35	385	515	775	1,030	1,160	1,930	3,220	5,795
1000	20	350	465	700	970	1,050	1,750	2,915	5,245
1050	20	345	460	685	960	1,030	1,720	2,865	5,155
1100	20	305	405	610	860	915	1,525	2,545	4,575
1150	20	235	315	475	735	710	1,185	1,970	3,550
1200	20	185	245	370	550	555	925	1,545	2,775
1250	20	145	195	295	485	440	735	1,230	2,210
1300	20	115	155	235	365	350	585	970	1,750
1350	20	95	130	190	275	290	480	800	1,440
1400	20	75	100	150	200	225	380	630	1,130
1450	20	60	80	115	155	175	290	485	875
1500	20	40	55	85	110	125	205	345	620

MATERIAL EQUIVALENCE

Description	Forging	Casting	Other Name
Carbon Steel	A105	A216 WCB	
Low-Temp Carbon Steel	A350 LF2	A352 LCC	
13 Chrome	A182 F6A	A217 CA15	
1-1/4 Chrome, 1/2 Moly	A182 F11	A217 WC6	
2-1/4 Chrome, 1 Moly	A182 F22	A217 WC9	
5 Chrome, 1/2 Moly	A182 F5	A217 C5	
9 Chrome, 1 Moly	A182 F9	A217 C12	
304L Stainless Steel	A182 F304L	A351 CF3	
304 Stainless Steel	A182 F304	A351 CF8	
316L Stainless Steel	A182 F316L	A351 CF3M	
316 Stainless Steel	A182 F316	A351 CF8M	
317L Stainless Steel	A182 F317L	A351 CG3B	
3-1/2 Nickel Steel	A350 LF2	A352 LC3	
347 Stainless Steel	A182 F347	A351 CF8C	
17-4PH Stainless Steel	A564 360	A564 630	
Alloy 20	A182 F20	A351 CN7M	Carpenter 20
Alloy 400	A564 N0440	A494 M35-1	Monel
Alloy 600	A564 N06600	A494 CY40	Inconel Alloy 600
Alloy 625	B564 N06625	A494 CW6MC	Inconel Alloy 625
Alloy B2	B564 N10665	A494 N12MV	Hastelloy B2
Alloy C22	B564 N06022	A494 CX2MW	Hastelloy C22
Alloy C276	B564 N10276	A494 CW12MW	Hastelloy C276
22% Duplex	A182 F51	A890 Gr. 4A	Duplex 2205
25% Duplex	A182 F53	A890 Gr. 6A	Duplex 2507
2545MO	A182 F44	A351 CK3MCuN	Super Austenitic Stainless Steel
Titanium	B381 F2	B367 C2	

REFERENCE DATA

FRACTION – DECIMAL – MILLIMETERS CONVERSION CHART

	INCHES	MILLIMETERS
1/64	.015625	.3969
1/32	.03125	.7938
3/64	.046875	1.1906
1/16	.0625	1.5875
5/64	.078125	1.9844
3/32	.09375	2.3813
7/64	.109375	2.7781
1/8	.125	3.1750
9/64	.140625	3.5719
5/32	.15625	3.9688
11/64	.171875	4.3656
3/16	.1875	4.7625
13/64	.203125	5.1594
7/32	.21875	5.5563
15/64	.234375	5.9531
1/4	.250	6.3500
17/64	.265625	6.7469
9/32	.28125	7.1438
19/64	.296875	7.5406
5/16	.3125	7.9375
21/64	.328125	8.3344
11/32	.34375	8.7313
23/64	.359375	9.1282
3/8	.375	9.5250
25/64	.390625	9.9219
13/32	.40625	10.3188
27/64	.421875	10.7157
7/16	.4375	11.1125
29/64	.453125	11.5094
15/32	.46875	11.9063
31/64	.484375	12.3032
1/2	.500	12.7001

	INCHES	MILLIMETERS
33/64	.515625	13.096
17/32	.53125	13.493
35/64	.546875	13.890
9/16	.5625	14.287
37/64	.578125	14.684
19/32	.59375	15.081
39/64	.609375	15.478
5/8	.625	15.875
41/64	.640625	16.271
21/32	.65625	16.668
43/64	.671875	17.065
11/16	.6875	17.462
45/64	.703125	17.859
23/32	.71875	18.256
47/64	.734375	18.653
3/4	.750	19.050
49/64	.765625	19.447
25/32	.78125	19.843
51/64	.796875	20.240
13/16	.8125	20.6375
53/64	.828125	21.0345
27/32	.84375	21.431
55/64	.859375	21.8282
7/8	.875	22.2251
57/64	.890625	22.6220
29/32	.90625	23.0188
59/64	.921875	23.4157
15/16	.9375	23.8126
61/64	.953125	24.2095
31/32	.96875	24.6063
63/64	.984375	25.0032
1	1.000	25.4001

METRIC CONVERSION CHART & TABLE

Length

1 centimeter (cm)	=	10 millimeters (mm)
1 inch	=	2.54 centimeters (cm)
1 foot	=	0.305 meters (m)
1 foot	=	12 inches
1 yard	=	3 feet
1 meter (m)	=	100 centimeters (cm)
1 meter (m)	≅	3.281 feet
1 furlong	=	660 feet
1 kilometer (km)	=	1000 meters (m)
1 kilometer (km)	≅	0.62137119 miles
1 mile	=	5280 ft
1 mile	=	1.61 kilometers (km)
1 nautical mile	=	1.85 kilometers (km)

Area

1 square foot	=	144 square inches
1 square foot	=	929.03 square centimeters
1 square yard	=	9 square feet
1 square meter	≅	10.76104 square feet
1 acre	=	43,560 square feet
1 hectare	=	10,000 square meters
1 hectare	≅	2.47 acres
1 square kilometer	=	100 hectares
1 square mile	≅	2.59 square kilometers
1 square mile	=	640 acres

Speed

1 mile per hour (mph)	≅	1.467 feet per second (fps)
1 mile per hour (mph)	=	1.61 kilometers per hour
1 knot	≅	1.15 miles per hour
1 foot per second	≅	0.68 miles per hour (mph)
1 kilometer per hour	≅	0.62 miles per hour (mph)

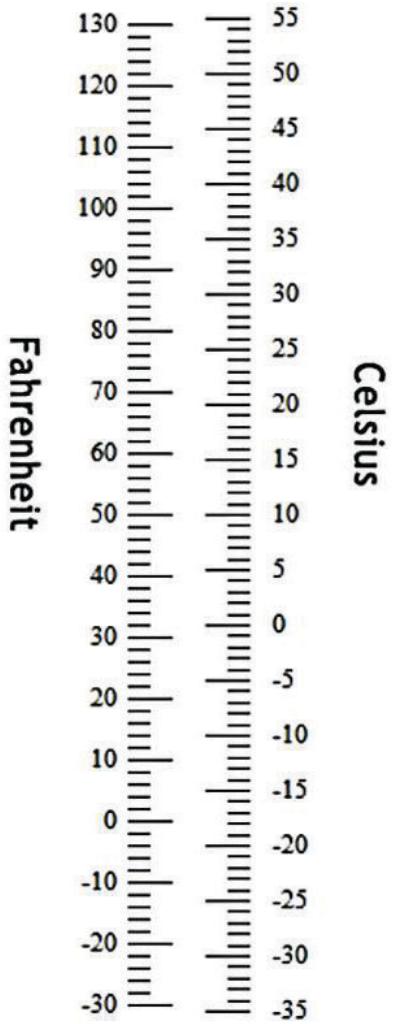
Volume

1 US tablespoon	=	3 US teaspoons
1 US fluid ounce	≅	29.57 milliliters (ml)
1 US cup	=	16 US tablespoons
1 US cup	=	8 US fluid ounces
1 US pint	=	2 US cups
1 US pint	=	16 US fluid ounces
1 liter (l)	≅	33.81 US fluid ounces
1 liter (l)	=	1000 milliliters (ml)
1 US quart	=	2 US pints
1 US gallon	=	4 US quarts
1 US gallon	=	3.785 liters

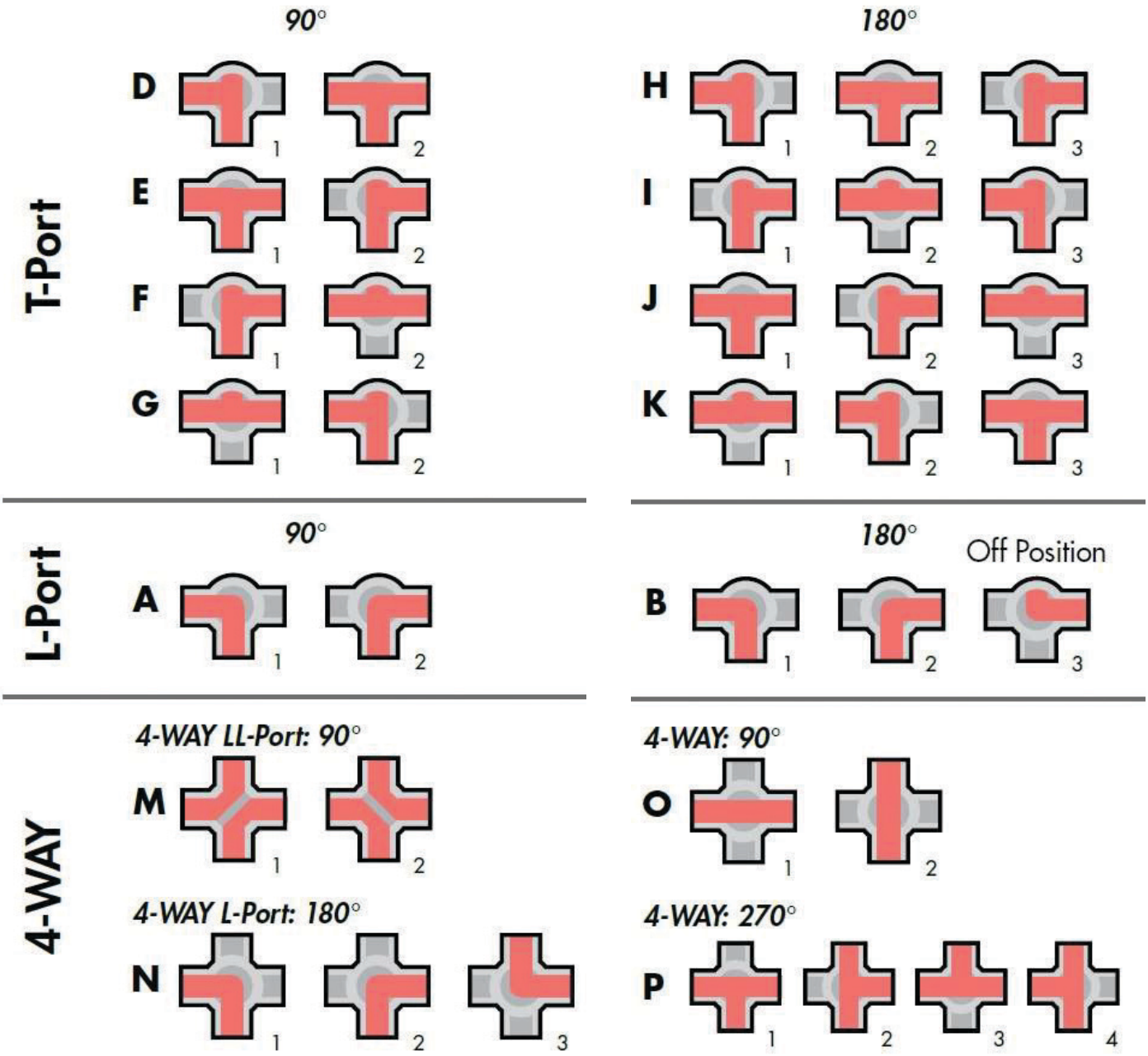
Weight

1 milligram (mg)	=	0.001 grams (g)
1 gram (g)	=	0.001 kilograms (kg)
1 gram (g)	≅	0.035 ounces
1 ounce	=	28.3 grams (g)
1 ounce	=	0.0625 pounds
1 pound (lb)	=	16 ounces
1 pound (lb)	=	0.45 kilograms (kg)
1 kilogram (kg)	=	1000 grams
1 kilogram (kg)	≅	35.27 ounces
1 kilogram (kg)	≅	2.2 pounds (lb)
1 stone	=	14 pounds
1 short ton	=	2000 pounds
1 metric ton	=	1000 kilograms (kg)

Temperature



THREE WAY FLOW PATTERNS



All T Port Flow Patterns are available from one standard ball and can be rearranged in the field.

VALVE LEAKAGE CLASSIFICATIONS

Per ANSI / FCI 70-2-2006

CLASS I – CLASS III

These classifications are not common in valves that have any type of seat.

CLASS IV – VALVE LEAKAGE CLASSIFICATIONS

- 0.01% leakage of full open valve capacity.
- Service dP or 50 psid (3.4 bar differential), whichever is lower at 50°F to 125°F.
- Test medium air at 45 to 60 psig is the test fluid.
- Class IV is also known as **metal to metal**

CLASS V – VALVE LEAKAGE CLASSIFICATIONS

- Intended for the same types of valves as Class IV.
- The test fluid is water at 100 psig or operating pressure.
- Leakage allowed is limited to 5 x 10 ml per minute per inch of orifice diameter per psi differential.
- Service dP at 50°F to 125°F.

CLASS VI – VALVE LEAKAGE CLASSIFICATIONS

Class VI is known as a soft seat classification. Soft Seat Valves are those where theseat or shut-off disc or both are made from some kind of resilient material such as Teflon. Intended for resilient seating valves.

- The test fluid is air or nitrogen.
- Pressure is the lesser of 50 psig or operating pressure.
- The leakage limit depends on valve size and ranges from 0.15 to 6.75 ml per minute for valve sizes 1 through 8 inches.

BUBBLE TIGHT

A commonly used term to describe the ability of a valve to shut off completely against any pressure on any fluid. This is a non-ANSI standard that is used by manufacturers to rate their valve shutoff as better than Class VI shutoff.

COMMON SEAT MATERIALS

Seat	Alternate Names	Good for	Do not use in these services	Common Valve Types
EPDM	EPT, Ethylene Propylene Diene Monomer	Water, light abrasives	Oils	Resilient Seated BFV, Knife Gate Valve, Dual Plate Check Valve
Buna	NBR, Nitrile, Buna-N	Water, Oils, Food & Beverage	Higher Temperatures (limited to 212F), Lower Temperatures (limited to 0F)	Resilient Seated BFV, Knife Gate Valve, Dual Plate Check Valve
Viton	FKM	Oils	Hot Water, Ketones	Resilient Seated BFV, Knife Gate Valve, Dual Plate Check Valve
Teflon	PTFE, VTFE, Virgin Teflon, TFM, PFA	Steam, Water, most Chemicals, Acids, Bases	Abrasives	HP Butterfly Valve, Ball Valve, Lined Plug Valve
Filled Teflon	RTFE, MTFE, CTFM, Reinforced Teflon, Xtreme	Steam, Water, most Chemicals, Acids, Bases	Sodium Hydroxide, Caustics, Hydrofluoric Acid	HP Butterfly Valve, Ball Valve, Lined Plug Valve
UHMWPE	Ultra-High Molecular Weight Polyethylene	Abrasives, Tobacco, Nuclear	Higher Temperatures (limited to 180F), Low Pressures (will not seal tight)	Sleeve Plug Valves, HP Butterfly Valve, Ball Valve

WALL THICKNESS SCHEDULES (ASME B36.10 / B36.19)

Nominal Pipe Size (NPS)		Outside Diameter		Nominal Wall Thickness																	
				Sch5s		Sch10s		Sch40s		Sch80s		Sch5		Sch10		Sch20		Sch30		STD	
A	B	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN
8	1/4	13.7	0.540	-	-	1.65	0.065	2.24	0.088	3.02	0.119	-	-	1.65	0.065	-	-	1.85	0.073	2.24	0.088
10	3/8	17.1	0.675	-	-	1.65	0.065	2.31	0.091	3.20	0.126	-	-	1.65	0.065	-	-	1.85	0.073	2.31	0.091
15	1/2	21.3	0.840	1.65	0.065	2.11	0.083	2.77	0.109	3.73	0.147	1.65	0.065	2.11	0.083	-	-	2.41	0.095	2.77	0.109
20	3/4	26.7	1.05	1.65	0.065	2.11	0.083	2.87	0.113	3.91	0.154	1.65	0.065	2.11	0.083	-	-	2.41	0.095	2.87	0.113
25	1	33.4	1.32	1.65	0.065	2.77	0.109	3.38	0.133	4.55	0.179	1.65	0.065	2.77	0.109	-	-	2.90	0.114	3.38	0.133
32	1¼	42.2	1.66	1.65	0.065	2.77	0.109	3.56	0.140	4.85	0.191	1.65	0.065	2.77	0.109	-	-	2.97	0.117	3.56	0.140
40	1½	48.3	1.9	1.65	0.065	2.77	0.109	3.68	0.145	5.08	0.200	1.65	0.065	2.77	0.109	-	-	3.18	0.125	3.68	0.145
50	2	60.3	2.38	1.65	0.065	2.77	0.109	3.91	0.154	5.54	0.218	1.65	0.065	2.77	0.109	-	-	3.18	0.125	3.91	0.154
65	2½	73.0	2.88	2.11	0.083	3.05	0.120	5.16	0.203	7.01	0.276	2.11	0.083	3.05	0.120	-	-	4.78	0.188	5.16	0.203
80	3	88.9	3.5	2.11	0.083	3.05	0.120	5.49	0.216	7.62	0.300	2.11	0.083	3.05	0.120	-	-	4.78	0.188	5.49	0.216
90	3½	101.6	4	2.11	0.083	3.05	0.120	5.74	0.226	8.08	0.318	2.11	0.083	3.05	0.120	-	-	4.78	0.188	5.74	0.226
100	4	114.3	4.5	2.11	0.083	3.05	0.120	6.02	0.237	8.56	0.337	2.11	0.083	3.05	0.120	-	-	4.78	0.188	6.02	0.237
125	5	141.3	5.56	2.77	0.109	3.40	0.134	6.55	0.258	9.53	0.375	2.77	0.109	3.40	0.134	-	-	-	-	6.55	0.258
150	6	168.3	6.62	2.77	0.109	3.40	0.134	7.11	0.280	10.97	0.432	2.77	0.109	3.40	0.134	-	-	-	-	7.11	0.280
200	8	219.1	8.62	2.77	0.109	3.76	0.148	8.18	0.322	12.70	0.500	2.77	0.109	3.76	0.148	6.35	0.250	7.04	0.277	8.18	0.322
250	10	273.0	10.75	3.40	0.134	4.19	0.165	9.27	0.365	12.70	0.500	3.40	0.134	4.19	0.165	6.35	0.250	7.80	0.307	9.27	0.365
300	12	323.8	12.75	3.96	0.156	4.57	0.180	9.53	0.375	12.70	0.500	3.96	0.156	4.57	0.180	6.35	0.250	8.38	0.330	9.53	0.375
350	14	355.6	14	3.96	0.156	4.78	0.188	9.53	0.375	12.70	0.500	3.96	0.156	6.35	0.250	7.92	0.312	9.53	0.375	9.53	0.375
400	16	406.4	16	4.19	0.165	4.78	0.188	9.53	0.375	12.70	0.500	4.19	0.165	6.35	0.250	7.92	0.312	9.53	0.375	9.53	0.375
450	18	457	18	4.19	0.165	4.78	0.188	9.53	0.375	12.70	0.500	4.19	0.165	6.35	0.250	7.92	0.312	11.13	0.438	9.53	0.375
500	20	508	20	4.78	0.188	5.54	0.218	9.53	0.375	12.70	0.500	4.78	0.188	6.35	0.250	9.53	0.375	12.70	0.500	9.53	0.375
550	22	559	22	4.78	0.188	5.54	0.218	9.53	0.375	12.70	0.500	4.78	0.188	6.35	0.250	9.53	0.375	12.70	0.500	9.53	0.375
600	24	610	24	5.54	0.218	6.35	0.250	9.53	0.375	12.70	0.500	5.54	0.218	6.35	0.250	9.53	0.375	14.27	0.562	9.53	0.375
650	26	660	26	-	-	-	-	-	-	-	-	-	-	7.92	0.312	12.70	0.500	-	-	9.53	0.375
700	28	711	28	-	-	-	-	-	-	-	-	-	-	7.92	0.312	12.70	0.500	15.88	0.625	9.53	0.375
750	30	762	30	6.35	0.250	7.92	0.312	9.53	0.375	12.70	0.500	6.35	0.250	7.92	0.312	12.70	0.500	15.88	0.625	9.53	0.375
800	32	813	32	-	-	-	-	-	-	-	-	-	-	7.92	0.312	12.70	0.500	15.88	0.625	9.53	0.375
850	34	864	34	-	-	-	-	-	-	-	-	-	-	7.92	0.312	12.70	0.500	15.88	0.625	9.53	0.375
900	36	914	36	-	-	-	-	-	-	-	-	-	-	7.92	0.312	12.70	0.500	15.88	0.625	9.53	0.375
950	38	965	38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.53	0.375
1000	40	1016	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.53	0.375
1050	42	1067	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.53	0.375
1100	44	1118	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.53	0.375
1150	46	1168	46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.53	0.375
1200	48	1219	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.53	0.375

WALL THICKNESS SCHEDULES (ASME B36.10 / B36.19)

Nominal Pipe Size (NPS)		Outside Diameter		Nominal Wall Thickness																	
				Sch40		Sch60		XS		Sch80		Sch100		Sch120		Sch140		Sch160		XXS	
A	B	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN
8	1/4	13.7	0.540	2.24	0.088	-	-	3.02	0.119	3.02	0.119	-	-	-	-	-	-	-	-	-	-
10	3/8	17.1	0.675	2.31	0.091	-	-	3.20	0.126	3.20	0.126	-	-	-	-	-	-	-	-	-	-
15	1/2	21.3	0.840	2.77	0.109	-	-	3.73	0.147	3.73	0.147	-	-	-	-	-	-	4.78	0.188	7.47	0.294
20	3/4	26.7	1.05	2.87	0.113	-	-	3.91	0.154	3.91	0.154	-	-	-	-	-	-	5.56	0.219	7.82	0.308
25	1	33.4	1.32	3.38	0.133	-	-	4.55	0.179	4.55	0.179	-	-	-	-	-	-	6.35	0.250	9.09	0.358
32	1¼	42.2	1.66	3.56	0.140	-	-	4.85	0.191	4.85	0.191	-	-	-	-	-	-	6.35	0.250	9.70	0.382
40	1½	48.3	1.9	3.68	0.145	-	-	5.08	0.200	5.08	0.200	-	-	-	-	-	-	7.14	0.281	10.15	0.400
50	2	60.3	2.38	3.91	0.154	-	-	5.54	0.218	5.54	0.218	-	-	-	-	-	-	8.74	0.344	11.07	0.436
65	2½	73.0	2.88	5.16	0.203	-	-	7.01	0.276	7.01	0.276	-	-	-	-	-	-	9.53	0.375	14.02	0.552
80	3	88.9	3.5	5.49	0.216	-	-	7.62	0.300	7.62	0.300	-	-	-	-	-	-	11.13	0.438	15.24	0.600
90	3½	101.6	4	5.74	0.226	-	-	8.08	0.318	8.08	0.318	-	-	-	-	-	-	-	-	-	-
100	4	114.3	4.5	6.02	0.237	-	-	8.56	0.337	8.56	0.337	-	-	11.13	0.438	-	-	13.49	0.531	17.12	0.674
125	5	141.3	5.56	6.55	0.258	-	-	9.53	0.375	9.53	0.375	-	-	12.70	0.500	-	-	15.88	0.625	19.05	0.750
150	6	168.3	6.62	7.11	0.280	-	-	10.97	0.432	10.97	0.432	-	-	14.27	0.562	-	-	18.26	0.719	21.95	0.864
200	8	219.1	8.62	8.18	0.322	10.31	0.406	12.70	0.500	12.70	0.500	15.09	0.594	18.26	0.719	20.62	0.812	23.01	0.906	22.23	0.875
250	10	273.0	10.75	9.27	0.365	12.70	0.500	12.70	0.500	15.09	0.594	18.26	0.719	21.44	0.844	25.40	1.000	28.58	1.125	25.40	1.000
300	12	323.8	12.75	10.31	0.406	14.27	0.562	12.70	0.500	17.48	0.688	21.44	0.844	25.40	1.000	28.58	1.125	33.32	1.312	25.40	1.000
350	14	355.6	14	11.13	0.438	15.09	0.594	12.70	0.500	19.05	0.750	23.83	0.938	27.79	1.094	31.75	1.250	35.71	1.406	-	-
400	16	406.4	16	12.70	0.500	16.66	0.656	12.70	0.500	21.44	0.844	26.19	1.031	30.96	1.219	36.53	1.438	40.49	1.594	-	-
450	18	457	18	14.27	0.562	19.05	0.750	12.70	0.500	23.83	0.938	29.36	1.156	34.93	1.375	39.67	1.562	45.24	1.781	-	-
500	20	508	20	15.09	0.594	20.62	0.812	12.70	0.500	26.19	1.031	32.54	1.281	38.10	1.500	44.45	1.750	50.01	1.969	-	-
550	22	559	22	-	-	22.23	0.875	12.70	0.500	28.58	1.125	34.93	1.375	41.28	1.625	47.63	1.875	53.98	2.125	-	-
600	24	610	24	17.48	0.688	24.61	0.969	12.70	0.500	30.96	1.219	38.89	1.531	46.02	1.812	52.37	2.062	59.54	2.344	-	-
650	26	660	26	-	-	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-
700	28	711	28	-	-	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-
750	30	762	30	-	-	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-
800	32	813	32	17.48	0.688	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-
850	34	864	34	17.48	0.688	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-
900	36	914	36	19.05	0.750	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-
950	38	965	38	-	-	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-
1000	40	1016	40	-	-	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-
1050	42	1067	42	-	-	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-
1100	44	1118	44	-	-	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-
1150	46	1168	46	-	-	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-
1200	48	1219	48	-	-	-	-	12.70	0.500	-	-	-	-	-	-	-	-	-	-	-	-

STEAM PRESSURE/TEMPERATURE

Gauge Press. in Hg. Vac.	Absolute Pressure psia	Temperature Degrees F	Sensible (hf) BTU/LB	Latent (hfg) BTU/lb	Total (hg) BTU/lb	Spec. Volume Steam (Vg) ft3/lb
27.96	1	101.7	69.5	1032.9	1102.4	333.0
25.91	2	126.1	93.9	1019.7	1113.6	173.5
23.81	3	141.5	109.3	1011.3	1120.6	118.6
21.83	4	153.0	120.8	1004.9	1125.7	90.52
19.79	5	162.3	130.1	999.7	1129.8	73.42
17.75	6	170.1	137.8	995.4	1133.2	61.89
15.7	7	176.9	144.6	991.5	1136.1	53.57
13.66	8	182.9	150.7	987.9	1138.6	47.26
11.62	9	188.3	156.2	984.7	1140.9	42.32
9.58	10	193.2	161.1	981.9	1143.0	38.37
7.54	11	197.8	165.7	979.2	1144.9	35.09
5.49	12	202.0	169.9	976.7	1146.6	32.35
3.45	13	205.9	173.9	974.3	1148.2	30.01
1.41	14	209.6	177.6	972.2	1149.8	28.0
Gauge Pressure psig						
0	14.7	212.0	180.2	970.6	1150.8	26.8
1	15.7	215.4	183.6	968.4	1152.0	25.2
2	16.7	218.5	186.8	966.4	1153.2	23.8
3	17.7	221.5	189.8	964.5	1154.3	22.5
4	18.7	224.5	192.7	962.6	1155.3	21.4
5	19.7	227.4	195.5	960.8	1156.3	20.4
6	20.7	230.0	198.1	959.2	1157.3	19.4
7	21.7	232.4	200.6	957.6	1158.2	18.6
8	22.7	234.8	203.1	956.0	1159.1	17.9
9	23.7	237.1	205.5	954.5	1160.0	17.2
10	24.7	239.4	207.9	952.9	1160.8	16.5
11	25.7	241.6	210.1	951.5	1161.6	15.9
12	26.7	243.7	212.3	950.1	1162.3	15.3
13	27.7	245.8	214.4	948.6	1163.0	14.8
14	28.7	247.9	216.4	947.3	1163.7	14.3
15	29.7	249.8	218.4	946.0	1164.4	13.9
16	30.7	251.7	220.3	944.8	1165.1	13.4
17	31.7	253.6	222.2	943.5	1165.7	13
18	32.7	255.4	224.0	942.4	1166.4	12.7
19	33.7	257.2	225.8	941.2	1167.0	12.3
20	34.7	258.8	227.5	940.1	1167.6	12
22	36.7	262.3	230.9	937.8	1168.7	11.4
24	38.7	265.3	234.2	935.8	1170.0	10.8

STEAM PRESSURE/TEMPERATURE

Gauge Press. in Hg. Vac.	Absolute Pressure psia	Temperature Degrees F	Sensible (hf) BTU/LB	Latent (hfg) BTU/lb	Total (hg) BTU/lb	Spec. Volume Steam (Vg) ft3/lb
26	40.7	268.3	237.3	933.5	1170.8	10.3
28	42.7	271.4	240.2	931.6	1171.8	9.87
30	44.7	274.0	243.0	929.7	1172.7	9.46
32	46.7	276.7	245.9	927.6	1173.5	9.08
34	48.7	279.4	248.5	925.8	1174.3	8.73
36	50.7	281.9	251.1	924.0	1175.1	8.40
38	52.7	284.4	253.7	922.1	1175.8	8.11
40	54.7	286.7	256.1	920.4	1176.5	7.83
42	56.7	289.0	258.5	918.6	1177.1	7.57
44	58.7	291.3	260.8	917.0	1177.8	7.33
46	60.7	293.5	263.0	915.4	1178.4	7.10
48	62.7	205.6	265.2	913.8	1179.0	6.89
50	64.7	297.7	267.4	912.2	1179.6	6.68
52	66.7	299.7	269.4	901.7	1180.1	6.50
54	68.7	301.7	271.5	909.2	1180.7	6.32
56	70.7	303.6	273.5	907.8	1181.3	6.16
58	72.7	305.5	275.3	906.5	1181.8	6.00
60	74.7	307.4	277.1	905.3	1182.4	5.84
62	76.7	309.2	279.0	904.0	1183.0	5.70
64	78.7	310.9	280.9	902.6	1183.5	5.56
66	80.7	312.7	282.8	901.2	1184.0	5.43
68	82.7	314.3	284.5	900.0	1184.5	5.31
70	84.7	316.0	286.2	898.8	1185.0	5.19
72	86.7	317.7	288.0	897.5	1185.5	5.08
74	88.7	319.3	289.4	896.5	1185.9	4.97
76	90.7	320.9	291.2	895.1	1185.9	4.87
78	92.7	322.4	292.9	893.9	1186.8	4.77
80	94.7	323.9	294.5	892.7	1187.2	4.67
82	96.7	325.5	296.1	891.5	1187.6	4.58
84	98.7	326.9	297.6	890.3	1187.9	4.49
86	100.7	328.4	299.1	889.2	1188.3	4.41
88	102.7	329.9	300.6	888.1	1188.7	4.33
90	104.7	331.2	302.1	887.0	1189.1	4.25
92	106.7	332.6	303.5	885.8	1189.3	4.17
94	108.7	333.9	304.9	884.8	1189.7	4.10
96	110.7	335.3	306.3	883.7	1190.0	4.03
98	112.7	336.6	307.7	882.6	1190.3	3.96
100	114.7	337.9	309.0	881.6	1190.6	3.90

STEAM PRESSURE/TEMPERATURE

Gauge Press. in Hg. Vac.	Absolute Pressure psia	Temperature Degrees F	Sensible (hf) BTU/LB	Latent (hfg) BTU/lb	Total (hg) BTU/lb	Spec. Volume Steam (Vg) ft3/lb
102	116.7	339.2	310.3	880.6	1190.9	3.83
104	118.7	340.5	311.6	879.6	1191.2	3.77
106	120.7	341.7	313.0	878.5	1191.5	3.71
108	122.7	343.0	314.3	877.5	1191.8	3.65
110	124.7	344.2	315.5	876.5	1192.0	3.60
112	126.7	345.4	316.8	875.5	1192.3	3.54
114	128.7	346.5	318.0	874.5	1192.5	3.49
116	130.7	347.7	319.3	873.5	1192.8	3.44
118	132.7	348.9	320.5	872.5	1193.0	3.39
120	134.7	350.1	321.8	871.5	1193.3	3.34
125	139.7	352.8	324.7	869.3	1194.0	3.23
130	144.7	355.6	327.6	866.9	1194.5	3.12
135	149.7	358.3	330.6	864.5	1195.1	3.02
140	154.7	360.9	333.2	862.5	1195.7	2.93
145	159.7	363.5	335.9	860.3	1196.2	2.84
150	164.7	365.9	338.6	858.0	1196.6	2.76
155	169.7	368.3	341.1	856.0	1197.1	2.68
160	174.7	370.7	343.6	853.9	1197.5	2.61
165	179.7	372.9	346.1	851.8	1197.9	2.54
170	184.7	375.2	348.5	849.8	1198.3	2.48
175	189.7	377.5	350.9	847.9	1198.8	2.41
180	194.7	379.6	353.2	845.9	1199.1	2.35
185	199.7	381.6	355.4	844.1	1195.5	2.30
190	204.7	383.7	357.6	842.2	1199.8	2.24
195	209.7	385.7	359.9	840.2	1200.1	2.18
200	214.7	387.7	362.0	838.4	1200.4	2.14
210	224.7	391.7	366.2	834.8	1201.0	2.04
220	234.7	395.5	370.3	831.2	1201.5	1.96
230	244.7	399.1	374.2	827.8	1202.0	1.88
240	254.7	402.7	378.0	824.5	1202.5	1.81
250	264.7	406.1	381.7	821.2	1202.9	1.74
260	274.7	409.3	385.3	817.9	1203.2	1.68
270	284.7	412.5	388.8	814.8	1203.6	1.62
280	294.7	415.8	392.3	811.6	1203.9	1.57
290	304.7	418.8	395.7	808.5	1204.2	1.52
300	314.7	421.7	398.9	805.5	1204.4	1.47
310	324.7	424.7	402.1	802.6	1204.7	1.43
320	334.7	427.5	405.2	799.7	1204.9	1.39

STEAM PRESSURE/TEMPERATURE

Gauge Press. in Hg. Vac.	Absolute Pressure psia	Temperature Degrees F	Sensible (hf) BTU/LB	Latent (hfg) BTU/lb	Total (hg) BTU/lb	Spec. Volume Steam (Vg) ft3/lb
330	344.7	430.3	408.3	796.7	1205.0	1.35
340	354.7	433.0	411.3	793.8	1205.1	1.31
350	364.7	435.7	414.3	791.0	1205.3	1.27
360	374.7	438.3	417.2	788.2	1205.4	1.24
370	384.7	440.8	420.0	785.4	1205.4	1.21
380	394.7	443.3	422.8	782.7	1205.5	1.18
390	404.7	445.7	425.6	779.9	1205.5	1.15
400	414.7	448.1	428.2	777.4	1205.6	1.12
420	434.7	452.8	433.4	772.2	1205.6	1.07
440	454.7	457.3	438.5	767.1	1205.6	1.02
460	474.7	461.7	443.4	762.1	1205.5	0.98
480	494.7	465.9	448.3	757.1	1205.4	0.94
500	514.7	470.0	453.0	752.3	1205.3	0.902
520	534.7	474.0	457.6	747.5	1205.1	0.868
540	554.7	477.8	462.0	742.8	1204.8	0.835
560	574.7	481.6	466.4	738.1	1205.5	0.805
580	594.7	485.2	470.7	733.5	1204.2	0.776
600	614.7	488.8	474.8	729.1	1203.9	0.750
620	634.7	492.3	479.0	724.5	1203.5	0.726
640	654.7	495.7	483.0	720.1	1203.1	0.703
660	674.7	499.0	486.9	715.8	1202.7	0.681
680	694.7	502.2	490.7	711.5	1202.2	0.660
700	714.7	505.4	494.4	707.4	1201.8	0.641
720	734.7	508.5	498.2	703.1	1201.3	0.623
740	754.7	51.5	501.9	698.9	1200.8	0.605
760	774.7	514.5	505.5	694.7	1200.2	0.588
780	794.7	517.5	509.0	690.7	0099.7	0.572
800	814.7	520.3	512.5	686.6	1199.1	0.557

CHEMICAL COMPATABILITY

A: Excellent
B: Good
C: Fair to Poor
D: Not recommended
-: No Data

Chemicals	Metals						Elastomers and Plastics							
	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Acetaldehyde	B	D	C	A	A	A	D	A	D	C	A	D	B	D
Acetamide	A	D	D	D	A	A	B	A	B	A	A	D	A	D
Acetate Solvents	B	D	D	D	A	D	D	B	D	D	A	D	B	D
Acetic Acid	B	D	D	D	B	A	C	A	C	B	A	C	B	C
Acetic Acid — 20%	B	D	D	B	A	C	C		B	B	A	B	A	-
Acetic Acid — 30%	D	-	A	A	-	C	C	A	-	B	A	B	A	-
Acetic Acid — 50%	D	-	A	A	-	C	C	A	-	B	A	B	A	-
Acetic Acid — 80%	B	D	D	D	B	A	C	A	B	A	A	C	-	-
Acetic Acid — Glacial	B	D	D	C	A	A	D	B	D	C	A	A	B	-
Acetic Acid Vapors	A	-	-	-	A	-	-	-	-	-	A	D	-	-
Acetic Anhydride	D	D	D	D	B	A	D	D	D	D	A	D	D	B
Acetone	B	A	A	A	A	A	D	A	D	D	A	D	A	D
Acetone 70°F	A	-	B	A	A	-	D	A	D	A	A	D	A	-
Acetone Cyanohydrin	B	-	B	B	-	-	D	D	-	-	A	-	-	-
Acetonitrile (Methyl Cyanide)	A	A	A	A	A	B	C	A	D	D	A	B	-	B
Acetophenone	B	A	A	A	B	B	D	B	D	C	A	B	-	-
Acetyl Acetone	D	-	B	B	-	-	D	A	D	-	A	-	-	D
Acetyl Chloride	D	B	B	B	B	A	D	D	B	D	A	A	-	D
Acetyl Sallicylic Acid (Aspirin)	D	-	B	B	-	-	-	B	A	-	A	-	A	-
Acetylene	A	A	A	A	A	A	B	A	A	D	A	A	-	D
Acetylene Tetrabromide	D	-	A	-	-	-	D	-	-	-	A	-	-	-
Acrolein (Acryaidethyde)	B	-	B	B	-	-	B	A	B	-	A	-	-	D
Acrylonitrile	B	A	A	A	A	B	D	D	D	B	A	B	-	D
Adipic Acid	B	A	B	B	B	A	C	A	A	B	A	B	A	-
Aero Lubriplate	A	A	A	A	A	A	A	D	A	A	A	A	-	-
Aerosafe 2300	A	A	A	A	A	-	D	A	D	-	A	-	-	A
Aerosafe 2300F	A	A	A	A	-	-	-	-	-	-	-	-	-	-
Aerosafe 2300W	A	-	A	A	-	-	D	A	D	-	A	-	-	D
Aeroshell 17 Grease	A	A	A	A	A	-	A	D	A	-	A	-	-	A
Aeroshell 1Ac	A	A	A	A	A	A	-	D	A	A	A	B	-	B
Aeroshell 750	A	A	A	A	A	-	B	D	A	-	A	-	-	A
Aeroshell 7A Grease	A	A	A	A	A	-	A	D	A	-	A	-	-	D
Alcohol	A	A	A	A	A	-	A	B	A	B	A	A	A	-
Alcohol: Amyl	B	B	B	A	A	A	B	A	B	B	A	A	A	D
Alcohol: Benzyl	B	B	B	B	B	A	D	C	A	A	A	A	A	C
Alcohol: Butyl	B	B	B	A	A	A	C	A	A	B	A	A	A	D
Alcohol: Diacetone	B	A	B	A	A	A	D	B	D	B	A	A	-	B
Alcohol: Ethyl	B	B	B	A	A	A	C	A	A	A	A	A	A	D
Alcohol: Hexyl	A	A	A	A	A	A	A	C	C	A	A	A	-	D
Alcohol: Isobutyl	B	C	C	A	A	A	C	B	A	A	A	A	-	D
Alcohol: Isopropyl	B	A	C	B	B	A	C	B	A	A	A	A	-	D
Alcohol: Methyl	B	A	A	A	A	A	A	B	D	A	A	A	A	D
Alcohol: Octyl	A	A	A	A	A	C	B	A	B	-	A	-	-	D
Alcohol: Propyl	A	A	A	A	A	A	A	B	A	A	A	A	C	D
Alcohols R-OH	-	-	-	-	-	A	A	-	-	A	-	A	A	-
Alkaline Solutions	-	-	-	A	A	-	A	A	-	-	A	-	A	-
Allyl Alcohol	B	A	A	A	A	A	A	A	B	B	A	A	A	B

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Allyl Bromide	D	-	A	-	-	-	D	D	B	-	A	-	-	A
Allyl Chloride	D	-	D	B	B	-	D	D	B	A	A	A	B	D
Ammonia, anhydrous	B	A	D	B	A	B	C	A	D	A	A	D	A	-
Ammonia, Liquids	D	-	A	-	A	B	B	-	D	A	A	A	-	-
Ammonium Acetate	B	-	A	B	A	-	B	A	A	A	A	-	A	D
Ammonium Bicarbonate	B	-	B	-	-	-	A	B	D	-	A	-	A	C
Ammonium Bifluoride	D	D	D	D	B	B	B	A	A	A	A	A	-	D
Ammonium Carbonate	C	B	C	B	B	B	D	B	B	A	A	A	A	A
Ammonium Casenite	-	-	-	A	A	-	D	-	-	-	A	-	-	-
Ammonium Chloride	D	D	D	C	C	D	B	A	A	A	A	A	A	-
Ammonium Chloride 1%	C	-	D	C	-	A	-	A	A	A	A	A	A	B
Ammonium Dichromate	A	-	A	-	-	-	A	A	-	-	A	-	-	-
Ammonium Diphosphate	D	B	B	-	B	-	-	A	A	-	A	-	-	-
Ammonium Fluoride	D	A	D	D	A	A	B	A	A	B	A	A	A	-
Ammonium Hydroxide	C	D	D	B	A	B	D	A	B	A	A	A	A	D
Ammonium Metaphosphate	B	-	B	B	-	-	A	A	-	A	A	A	A	-
Ammonium Nitrate	B	B	D	A	A	B	A	A	B	A	A	A	A	A
Ammonium Nitrite	-	-	-	A	-	-	A	A	A	A	A	A	A	D
Ammonium Oxalate	-	D	D	A	A	-	D	A	-	A	-	-	A	-
Ammonium Oxalate - 5% Sol.	-	-	D	A	-	A	-	A	-	-	A	-	A	-
Ammonium Persulfate	D	D	D	A	B	B	D	B	A	A	A	A	A	D
Ammonium Phosphate	B	-	D	A	A	A	A	A	A	A	A	A	B	B
Ammonium Phosphate, Dibasic	B	D	D	B	C	B	A	A	A	A	A	A	-	-
Ammonium Phosphate,	D	D	D	B	C	B	A	A	A	A	A	A	A	-
Ammonium Phosphate,	D	D	D	B	B	B	A	A	A	A	A	A	-	-
Ammonium Sulfate	D	D	D	B	B	B	A	A	D	A	A	A	A	A
Ammonium Sulfide	B	-	-	B	-	A	A	A	D	-	A	-	A	B
Ammonium Sulfite	D	D	D	B	B	A	A	A	D	A	A	-	D	D
Ammonium Sulphate 1% - 5%	B	-	C	A	-	B	-	-	D	A	A	A	A	B
Ammonium Thiocyanate	C	-	C	A	-	A	A	A	A	-	A	A	A	-
Ammonium Thiosulfate	A	D	D	A	A	-	A	A	A	-	A	-	-	-
Amyl Acetate (Banana Oil)	B	C	C	A	A	B	D	A	D	D	A	A	B	D
Amyl Alchol	B	-	-	A	-	A	B	-	-	B	A	A	A	-
Amyl Alcohol	B	B	C	A	A	B	B	A	B	B	A	A	A	D
Amyl Chloride (Chloropentane)	D	A	A	A	A	B	D	D	B	D	A	A	D	C
Amyl Phenol	A	-	A	A	-	A	D	-	A	-	A	-	-	-
Aniline	C	C	C	A	B	B	D	D	D	C	A	C	C	D
Aniline Dyes	B	-	C	B	B	-	C	C	A	-	A	-	C	D
Aniline Hydrochloride	D	D	D	D	D	D	D	B	B	D	A	B	C	D
Aniline Sulfite	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Animal Fats & Oils	A	A	D	A	A	A	A	B	A	A	A	A	A	C
Anisole (Methylphenyl Ether)	B	-	B	B	-	B	-	-	-	-	A	-	C	-
Anthaquinone	B	-	B	B	-	A	-	C	D	-	A	-	-	B
Anti-Freeze (Alcohol Base)	A	A	A	A	A	A	A	A	A	D	A	-	-	-

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Anti-Freeze (Glycol Base)	A	A	A	A	A	A	A	A	A	A	A	A	A	B
Antimonty Trichloride	B	-	A	A	-	B	-	B	A	A	A	A	A	D
Antimony Chloride	B	-	A	A	-	B	-	A	B	A	A	A	A	-
Antimony Pentachloride	A	-	A	A	-	A	D	-	-	-	A	-	A	-
Antimony Trichloride	D	-	D	D	D	B	B	B	A	A	A	A	A	-
Aqua Regia (80%, Hci, 20%	D	D	D	D	D	D	D	D	C	D	A	A	B	D
Aresenic Acid	D	-	D	A	-	B	-	A	A	A	A	A	A	C
Aresenic Trichloride	D	-	D	D	-	B	-	D	A	-	A	-	-	-
Arochlor 1248	A	B	B	B	B	A	D	B	A	D	A	-	-	-
Automatic Transmission Fluid	A	A	A	A	A	A	A	D	A	-	A	-	-	B
Automotive Gasoline	A	A	A	A	A	-	A	D	A	-	A	-	-	-
Aviation Gasoline	A	A	A	A	A	A	B	D	A	-	A	-	-	D
Banana Oil	-	-	-	A	A	-	A	-	-	-	A	-	-	-
Barbeque Sauce	-	D	D	A	A	-	A	-	-	-	A	-	-	-
Barium Carbonate	D	A	B	B	B	B	A	A	A	A	A	A	B	B
Barium Chloride	D	C	D	B	C	B	A	A	A	A	A	A	B	A
Barium Cyanide	C	C	C	A	A	A	C	A	A	D	A	-	-	-
Barium Hydroxide	D	D	D	B	B	B	A	A	A	B	A	A	A	A
Barium Nitrate	B	A	A	B	B	A	A	A	A	A	A	A	B	B
Barium Sulfate	D	B	B	B	B	A	A	A	A	B	A	A	A	A
Barium Sulfide	D	D	D	B	B	A	A	A	A	B	A	A	B	A
Beef Extract	-	-	D	A	-	-	A	-	A	-	A	-	-	-
Beer	A	D	D	A	A	A	C	A	A	B	A	A	A	-
Beer (Alcohol Ind.)	A	A	A	A	A	-	B	A	A	-	A	-	-	-
Beer (Beverage Ind.)	A	D	D	A	A	-	A	A	A	-	A	-	-	-
Beet Sugar Liquids	A	A	A	A	A	-	A	A	-	B	A	A	-	-
Beet Sugar Liquors	A	B	B	A	A	-	A	A	A	-	A	-	-	-
Beet Sugar Liquors (Sucrose)	A	-	B	A	-	-	A	A	A	A	A	A	-	-
Benzaldehyde	B	A	A	B	B	A	D	B	D	D	A	A	C	D
Benzene	B	A	B	B	B	B	D	D	B	D	A	B	D	D
Benzene Hot	B	-	B	B	B	-	C	-	-	D	A	B	D	-
Benzene Sulfonic Acid	D	-	D	B	B	B	D	D	B	D	A	B	D	D
Benzoic Acid	B	D	D	B	B	B	D	D	A	D	A	A	A	D
Benzol	B	A	B	A	A	B	D	D	D	D	A	A	D	D
Benzonitrile	-	-	-	D	D	C	-	-	-	-	A	-	-	-
Benzoyl Chloride	D	-	A	B	-	B	D	D	-	-	A	A	-	-
Benzyl Acetate	A	-	A	A	-	B	D	-	D	-	A	-	C	-
Benzyl Alchol (Phenylcarbinol)	B	-	-	A	-	A	D	-	-	A	A	A	A	-
Benzyl Alcohol	A	A	A	A	A	B	D	C	A	A	A	A	A	D
Benzyl Benzoate	A	-	B	B	B	B	D	B	A	-	A	-	-	D
Benzyl Chloride	D	A	D	C	B	C	D	D	C	D	A	C	A	D
Benzyl Dichloride (Benzal	D	-	B	A	-	B	D	-	-	-	A	-	-	-
Biphenyl (Diphenyl)	A	-	A	-	-	-	D	D	A	-	A	-	-	D
Bismuth Subcarbonate	-	-	-	B	-	-	A	A	-	-	A	-	A	D
Black Point 77	-	-	-	B	-	-	-	A	A	-	A	-	-	C

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Black Sulfate Liquor	C	-	B	A	-	B	B	B	B	-	A	A	A	D
Bleach Solutions	D	-	D	B	-	B	D	A	B	D	A	A	B	D
Bleaching Powder (Wet)	-	-	-	A	D	-	A	-	-	-	A	-	-	-
Blood	-	-	-	A	-	-	-	-	-	A	A	-	-	-
Blood (Meat Juices - Cold)	A	-	D	B	A	-	B	A	C	A	A	-	A	D
Borax (Sodium Borate)	D	A	D	A	A	B	B	A	A	B	A	A	A	A
Bordeaux Mixtures	D	-	C	A	A	A	A	A	A	-	A	-	A	D
Boric Acid	D	D	D	B	A	A	A	A	A	A	A	A	A	A
Brake Fluid (Non-Petroleum	A	A	A	A	A	A	D	A	D	D	A	-	A	A
Brewery Slop	-	A	A	A	A	-	A	A	A	-	A	-	-	A
Brine (Calcium Chloride)	C	-	D	A	-	A	A	A	A	A	A	A	A	B
Brine (Sodium Chloride)	-	-	D	A	-	A	A	A	-	A	A	A	A	-
Bromine	D	-	D	D	D	A	D	D	A	D	A	A	D	D
Bromine Dry Gas	D	-	D	D	D	-	-	-	-	D	A	A	D	-
Butyl Benzoate	B	-	B	B	B	B	-	B	A	-	A	-	-	D
Butyl Butyrate	A	-	A	A	-	A	D	A	-	-	A	-	-	-
Butyl Chloride	D	-	B	B	-	B	D	-	A	D	A	A	-	-
Butyl Ether	B	-	B	B	A	B	B	D	D	D	A	A	A	-
Butyl Phthalate	B	-	-	B	B	B	D	B	C	B	A	D	A	-
Butyl Stearate	B	-	B	B	B	B	A	D	A	-	A	A	A	B
Butylene	A	-	-	A	A	-	B	D	A	D	A	A	-	C
Butylene (Butene)	A	-	-	A	-	-	B	D	-	D	A	A	-	-
Butyraidehyde	A	-	A	A	-	A	D	C	D	D	A	B	C	D
Butyric Acid	B	D	D	B	B	A	D	C	B	B	A	A	B	D
Butyric Acid, Aqeous	B	-	-	-	A	A	D	-	D	A	A	A	-	-
Butyric Anhydride	A	-	A	-	A	A	-	-	-	-	A	-	D	-
Calcium Acetate (Hydrate)	C	-	C	B	-	B	B	A	D	-	A	-	-	D
Calcium Bisulfate	-	D	D	-	A	-	A	A	A	-	A	-	-	A
Calcium Bisulfide	C	-	D	B	B	A	A	D	A	A	A	A	-	A
Calcium Bisulfite	D	-	D	B	A	B	B	D	A	B	A	D	A	A
Calcium Carbonate (Chalk)	D	-	B	B	B	B	A	A	A	A	A	A	A	D
Calcium Chlorate	B	-	B	B	-	B	A	A	A	A	A	A	A	B
Calcium Chloride	D	C	C	C	C	A	A	A	A	A	A	A	-	-
Calcium Chloride (Brine)	C	-	C	C	-	A	A	A	A	A	A	A	A	A
Calcium Chloride Saturated	-	A	A	A	A	-	A	A	A	A	A	A	A	-
Calcium Hydroxide	C	A	A	B	B	A	A	A	A	A	A	A	-	-
Calcium Hydroxide - 10%	C	-	A	A	-	A	-	A	A	A	A	A	D	A
Calcium Hydroxide (Slaked	D	-	B	B	-	A	A	A	-	A	A	A	-	-
Calcium Hydroxide 10%	-	A	A	A	A	-	A	A	A	A	A	A	D	-
Calcium Hydroxide 20%	-	-	-	A	A	-	D	-	-	A	A	A	D	-
Calcium Hydroxide 30%	-	-	-	A	A	-	D	-	-	A	A	A	A	-
Calcium Hypochlorite	D	D	D	C	C	B	C	B	A	A	A	A	A	D
Calcium Hypochlorite 2%	D	-	C	C	B	-	D	-	-	A	A	A	D	-
Calcium Hypochlorite 20%	D	-	D	B	-	B	C	B	-	A	A	A	A	-
Calcium Nitrate	B	B	C	C	B	B	A	B	A	A	A	A	A	D
Calcium Nitrite	-	-	-	A	A	-	A	A	-	A	A	A	-	-
Calcium Oxide	C	-	-	A	A	A	A	A	B	A	A	A	-	-
Calcium Oxide (Unslaked	A	-	A	A	-	A	A	A	A	-	A	-	A	B

CHEMICAL COMPATABILITY

A: Excellent
B: Good
C: Fair to Poor
D: Not recommended
-: No Data

Chemicals	Metals						Elastomers and Plastics							
	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Calcium Silicate	A	-	B	A	-	A	A	A	A	-	A	-	-	-
Calcium Sulfate	C	A	C	B	B	B	A	A	A	A	A	D	A	B
Calcium Sulfide	A	-	B	B	B	A	A	A	A	A	A	A	-	A
Calcium Sulfite	B	-	B	A	-	-	A	A	A	-	A	-	-	A
Calgon	-	D	D	A	A	-	A	A	A	A	A	-	-	D
Cane Juice	B	A	A	A	A	-	A	A	A	D	A	B	-	D
Cane Sugar Liquors	A	A	B	A	A	-	A	A	A	A	A	A	-	D
Capryl Alcohol (Octanol)	A	-	A	A	-	A	A	C	B	-	A	-	-	D
Caprylic Acid (Octanoic Acid)	A	-	-	A	-	A	C	A	A	-	A	A	-	-
Carbitol	B	-	B	B	B	A	B	C	A	C	A	A	-	D
Carbolic Acid (Phenol)	B	D	D	B	B	A	D	C	A	C	A	B	B	C
Carbon Bisulfide	B	-	B	B	B	B	D	D	A	D	A	A	D	C
Carbon Dioxide	A	A	D	A	A	A	A	B	B	A	A	A	C	C
Carbon Dioxide (dry)	B	D	D	A	A	A	A	B	B	A	A	A	-	-
Carbon Dioxide (wet)	A	D	D	A	A	A	A	B	B	A	A	A	-	-
Carbon Disulfide	C	A	B	B	B	B	D	D	A	D	A	B	D	C
Carbon Monoxide	A	A	A	A	A	B	C	C	A	A	A	B	C	A
Chlorine Trifluoride	D	-	D	A	A	-	D	D	D	D	A	-	D	D
Chlorine Water	D	-	-	C	C	A	D	C	A	D	A	B	-	-
Chlorine, Anhydrous Liquid	D	D	D	D	D	D	D	D	A	D	A	A	D	D
Chloroacetic Acid	D	D	D	D	B	A	D	B	D	C	A	B	D	D
Chloroacetone	D	-	B	B	B	B	D	D	B	D	A	-	-	D
Chlorobenzene	D	B	C	B	B	B	D	D	A	D	B	B	B	D
Chlorobromomethane	D	B	B	B	B	-	D	B	A	D	A	-	D	D
Chlorobutadiene	D	-	B	B	A	B	D	D	A	D	A	-	-	D
Chlorododecane	D	-	D	-	-	-	D	D	A	D	A	-	-	D
Chloroethanol	B	-	B	-	B	-	-	-	-	D	A	C	-	-
Chloroform	D	B	D	A	A	B	D	D	A	D	A	B	D	D
Chlorol 1 Nitro Ethane	D	-	-	-	-	-	D	D	D	D	A	-	-	D
Chloronaphthalene	D	-	B	B	B	B	D	D	A	D	A	A	C	D
Chlorophenol	C	-	C	B	B	A	-	D	B	-	A	B	-	D
Chlorosulfonic Acid	D	D	D	D	D	B	D	D	D	D	A	D	D	-
Chlorosulfonic Acid (Dry)	D	-	D	D	-	B	-	C	C	C	A	C	D	D
Chlorosulfonic Acid (Wet)	D	-	D	D	-	B	-	D	D	C	A	C	D	D
Chlorosulfonic Acid Dilute	D	-	D	D	D	-	B	-	-	C	A	-	C	-
Chlorothene® (Chlorinated	D	-	D	A	-	A	D	-	-	-	A	-	-	-
Chlorotoluene	D	-	B	B	B	A	D	D	A	D	A	-	-	D
Chlorotrifluoroethylene	B	-	B	B	-	B	D	-	-	-	A	-	-	-
Chlorox® (Bleach)	D	D	D	A	A	B	D	B	A	D	A	A	-	-
Chocolate Syrup	A	D	D	A	A	A	A	A	A	A	A	-	-	-
Chrome Plating Solutions	D	-	D	-	D	-	D	-	A	B	A	A	-	-
Chromic Acid - 25%-50%	D	-	B	D	-	B	D	C	-	A	A	A	A	-
Chromic Acid - 5%	C	D	D	B	A	B	D	A	A	D	A	A	A	D
Chromic Acid - 50%	D	D	D	C	B	B	D	C	A	D	A	A	A	D
Chromic Acid - Over 50%	D	-	B	D	-	B	D	C	-	D	A	A	A	-
Chromic Acid - To 10%	B	-	B	D	-	B	D	A	-	D	A	A	A	-
Chromic Acid 10%	D	D	D	B	B	A	D	C	B	D	A	A	-	-

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Chromic Acid 30%	D	D	D	B	B	D	D	B	A	D	A	A	-	-
Chromic Acid Concentrated	D	D	C	C	C	-	D	-	-	B	A	B	A	-
Chromic Acid Dilute	-	-	-	A	A	-	D	C	-	A	A	A	A	-
Cider (Apple Juice)	B	D	D	A	A	A	A	A	A	A	A	-	A	D
Citric Acid	C	D	D	B	A	A	B	A	A	B	A	A	A	-
Citric Acid - 5% Solution	C	-	D	A	-	A	-	A	A	A	A	A	A	A
Citric Acid Concentrated	-	-	-	-	A	-	A	A	A	A	A	A	A	-
Citric Acid Dilute	A	-	-	A	A	-	B	-	-	A	A	A	A	-
Citrus Pectin Liquor	-	-	-	A	-	-	A	-	C	-	A	-	D	C
Cloracetic Acid	D	-	D	-	C	A	D	-	D	B	A	A	-	-
Coal Tars	-	-	-	-	-	A	-	D	A	C	A	-	-	D
Cobalt Chloride	D	-	D	-	-	-	A	C	A	A	A	-	-	D
Coca Cola Syrup	-	-	-	A	A	-	-	A	B	-	A	-	-	B
Coconut Oil (Coconut Butter)	B	A	A	A	A	A	B	D	A	A	A	A	A	C
Cod Liver Oil	B	-	D	A	A	A	B	A	A	A	A	A	A	A
Coffee	A	-	-	A	A	A	A	A	A	A	A	-	A	D
Coke Oven Gas	C	A	A	-	A	-	C	D	A	-	A	A	A	D
Coolanol (Monsanto)	D	-	D	C	-	B	-	D	A	-	-	A	-	D
Copper Acetate	D	-	D	C	C	B	B	A	D	-	A	A	-	D
Copper Chloride	D	-	D	D	D	B	A	A	A	A	A	A	A	-
C Chl id 1%	D		D	D		B		A	A	A	A	A	A	D
Crotonaldehyde	A	-	A	A	-	A	D	A	D	-	A	-	-	D
Crude Oil	A	-	B	A	A	B	-	D	A	D	A	A	B	D
Cumeme (Isopropylbenzene)	B	-	B	B	-	B	D	D	A	-	A	-	A	D
Cupric Acid	D	-	-	D	B	A	B	A	A	A	A	-	-	-
Cupric Chloride	D	-	D	B	B	-	-	-	-	B	A	B	A	-
Cutting Oil (Sulfur Base)	A	A	A	A	A	A	A	D	A	-	A	-	A	A
Cutting Oil (Water Soluble)	A	A	A	A	A	A	C	D	A	-	A	-	A	A
Cyanic Acid	-	D	D	A	A	-	C	A	D	-	A	-	-	D
Cyclohexane	B	B	B	B	A	B	B	D	A	D	A	A	A	B
Cyclohexanol	C	A	B	B	B	A	C	D	A	B	A	A	A	B
Cyclohexanone	B	B	B	B	B	B	D	C	D	D	A	D	B	D
Cyclopentane	B	-	B	B	-	B	B	D	-	-	A	-	-	-
De-Ionized Water	A	-	C	A	-	A	A	A	A	A	A	A	A	-
Denatured Alcohol	B	-	B	A	A	A	A	A	B	A	A	A	-	D
Detergent Solutions	B	-	A	A	A	B	A	A	A	A	A	A	A	A
Detergents General	A	-	A	A	A	-	A	A	-	B	A	-	A	-
Developing Fluids (Photo)	-	-	D	A	B	A	A	C	A	-	A	-	A	D
Dextrose	A	-	D	A	-	A	B	A	A	A	A	A	A	A
Diacetone	A	-	A	A	A	A	D	B	D	D	A	A	-	-
Diacetone Alcohol	A	-	A	B	B	A	D	B	D	D	A	D	-	-
Diacetone Alcohol (Acetal)	A	A	A	A	A	-	D	A	D	B	A	B	-	-
Diacetone Alcohol (Diacetol)	A	-	A	A	-	A	-	A	D	B	A	A	-	D
Dibenzyl Ether	B	-	B	B	B	B	D	C	C	-	A	C	-	B
Dibutyl Amine	-	-	A	A	-	A	C	D	B	D	A	B	-	D
Dibutyl Ether	B	-	B	-	B	-	B	C	C	D	A	A	-	D
Dibutyl Phthalate	A	A	A	A	A	A	D	B	C	D	A	D	A	C

CHEMICAL COMPATABILITY

A: Excellent
B: Good
C: Fair to Poor
D: Not recommended
-: No Data

Chemicals	Metals						Elastomers and Plastics							
	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Dibutyl Sebecate	-	-	A	A	A	-	D	C	B	C	A	D	-	D
Dichlorethane	-	-	D	A	-	B	-	D	B	A	A	A	C	D
Dichloro Isopropyl Ether	D	-	-	-	-	-	D	D	C	D	A	-	-	B
Dichlorobenzene	B	A	A	A	B	A	D	D	C	D	A	B	D	-
Dichlorobutane	D	-	B	B	-	-	D	D	A	-	A	-	-	D
Dichlorodifluoro Methane	A	-	A	A	-	-	-	-	-	B	A	A	-	-
Dichloroethane	B	A	A	B	B	A	D	-	C	D	A	B	D	-
Dichloroethyl Ether	B	-	-	-	-	-	D	-	-	-	A	-	-	-
Dichloro-Isopropyl Ether	D	-	-	-	-	-	D	-	C	D	A	-	-	-
Diemethyl Formamide	A	-	A	A	-	A	-	B	D	A	A	D	A	D
Diemethyl Phthalate	A	-	A	A	-	A	-	B	A	A	A	A	-	D
Diesel Fuel	A	A	A	A	A	B	A	D	A	B	A	A	D	-
Diesel Oil (Fuel ASTM #2)	A	-	A	A	-	A	A	D	A	B	A	A	A	B
Di-Ester Synthetic Lubricants	A	-	A	A	-	A	-	D	A	-	A	-	-	D
Diester Synthetic Oils	A	-	A	A	-	A	B	D	-	-	A	-	-	-
Diethanol Amine	A	-	A	A	-	A	B	A	D	A	A	-	-	D
Diethanolamine	A	A	A	A	-	-	-	-	-	B	A	-	-	-
Diethyl Amine	B	-	D	B	-	A	C	C	D	A	A	A	-	C
Diethyl Carbonate	-	-	A	-	-	-	D	D	A	-	A	-	-	D
Diethyl Ether	B	B	B	B	B	B	D	D	D	D	A	B	D	A
Diethyl Phthalate (DEP)	A	-	A	A	-	A	D	-	C	-	A	-	-	-
Diethyl Sebecate	A	-	A	A	A	A	D	C	A	A	A	A	-	D
Diethylamine	B	B	D	B	B	A	C	B	D	C	D	D	-	-
Diethylene Ether (Dioxane)	A	-	A	A	-	-	D	D	-	-	A	-	-	-
Diethylene Glycol	B	A	A	A	A	B	A	A	A	A	A	A	A	D
Dispersing Oil #10	A	-	A	A	-	A	D	D	C	-	A	-	-	-
Dodecyl Benzene (Alkane)	A	-	A	A	-	-	D	-	A	-	A	-	-	-
Dow (Silicones)	A	-	-	-	-	-	A	A	A	-	A	-	-	A
Dowtherm A	C	-	B	A	-	-	-	D	A	B	A	-	-	D
Dowtherm Oil	C	A	B	A	A	A	D	D	A	A	A	D	D	-
Dry Cleaning Fluid	A	A	A	A	A	-	D	D	A	D	A	A	D	D
Dyes	B	-	B	A	A	A	C	-	A	-	-	-	-	-
Epichlorohydrin	D	A	A	A	A	A	D	C	D	B	A	D	-	D
Epsom Salts (Magnesium	B	A	A	A	B	B	A	A	A	A	A	A	A	-
Ethane	A	A	A	A	A	A	A	D	A	D	A	A	-	B
Ethanol (Ethyl Alcohol)	B	B	B	A	A	A	C	A	A	A	A	A	A	D
Ethanolamine	B	A	B	A	A	B	B	B	D	D	A	D	A	C
Ether	B	C	C	A	A	B	D	C	C	D	A	B	-	-
Ether Sulfate	-	B	-	D	D	-	-	-	-	-	A	-	-	-
Ethers	B	B	C	B	B	B	-	C	D	D	A	D	D	D
Ethyl Acetate	B	A	A	B	B	B	D	B	D	C	A	D	B	D
Ethyl Acetate 120° F	B	-	B	B	B	-	A	-	-	B	A	-	A	-
Ethyl Acetate 140° F	B	-	B	B	B	-	-	-	-	B	A	D	D	-
Ethyl Acetate 70° F	B	B	B	B	B	-	A	-	-	A	A	A	A	-
Ethyl Acetoacetate	A	-	A	A	-	A	D	C	D	-	A	A	A	D
Ethyl Acrylate	A	-	A	A	A	A	D	C	D	D	A	C	-	D
Ethyl Alchol (Ethanol)	B	-	B	A	-	A	A	-	-	A	A	A	A	-

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Ethyl Alcohol (Ethanol)	B	-	B	A	-	A	A	A	A	A	A	A	A	D
Ethyl Amine (Monoethylamine)	B	-	B	A	-	-	D	A	D	-	A	-	-	D
Ethyl Benzene	B	A	B	B	B	A	D	D	A	D	A	C	A	D
Ethyl Benzoate	A	A	A	A	A	A	D	D	A	C	A	D	-	D
Ethyl Bromide (Bromoethane)	A	-	A	A	-	-	D	D	A	D	A	-	-	D
Ethyl Butyrate	B	A	B	A	A	A	D	D	C	D	A	-	C	-
Ethyl Cellulose	B	-	A	B	B	B	B	B	D	C	A	-	-	B
Ethyl Chloride	D	C	C	A	A	B	A	A	A	D	A	A	D	C
Ethyl Chloride Wet	B	-	D	D	A	-	A	A	A	D	A	A	D	-
Ethyl Chlorocarbonate	D	-	A	-	-	-	-	D	A	-	A	-	-	D
Ethyl Chloroformate	D	-	-	-	-	-	-	D	A	D	A	-	-	D
Ethyl Ether	C	C	C	B	B	B	D	D	D	D	A	B	D	D
Ethyl Formate	C	-	A	B	B	B	D	C	C	-	A	-	C	-
Ethyl Mercaptan	B	-	A	B	B	B	D	D	B	-	A	-	-	A
Ethyl Oxalate	A	-	-	-	-	-	D	A	B	-	A	-	-	A
Ethyl Pentachlorobenzene	D	-	-	-	-	-	D	D	A	D	A	-	-	C
Ethyl Propionate	A	-	A	A	-	A	D	D	-	-	A	-	-	-
Ethyl Silicate	B	-	A	A	A	A	A	A	A	-	A	-	C	D
Ethyl Sulfate	-	-	-	D	D	-	A	A	D	-	A	-	-	D
Ethylene (Ethene)	A	-	A	A	A	-	B	D	A	-	A	-	-	B
Ethylene Bromide	D	-	B	A	B	B	D	C	A	D	A	A	-	-
Ethylene Chloride	D	-	C	B	B	B	D	D	C	D	A	A	C	D
Ethylene Chlorohydrin	D	B	B	B	B	B	D	B	B	D	A	B	-	D
Ethylene Glycol Monomethyl	B	-	B	A	-	A	C	B	-	-	A	-	-	-
Eth l O id	D	D	D	C	C	A	D	D	D	D	A	B	C	D
Fluorocarbon Oils	D	-	A	A	-	A	C	A	-	D	A	-	-	-
Fluosilicic Acid	D	D	D	C	B	B	B	B	B	A	A	B	A	B
Formaldehyde	B	C	D	D	A	B	C	A	D	C	B	A	A	D
Formaldehyde 40%	B	B	B	A	A	B	B	A	A	A	A	A	-	-
Formamide	A	-	B	B	-	B	A	A	D	-	A	-	-	-
Formic Acid	D	D	D	C	C	A	D	B	C	B	A	A	A	D
Freon - Wet	B	-	D	C	D	-	-	-	-	-	-	-	-	-
Freon 11	D	A	C	A	A	A	C	D	C	D	A	B	-	D
Freon 112	D	A	A	A	A	-	B	D	A	-	A	-	-	B
Freon 113	D	A	A	A	A	A	B	D	C	D	A	B	-	B
Freon 114	D	A	A	A	A	-	A	D	A	D	A	A	-	A
Freon 114B2	D	A	A	A	A	-	B	D	B	-	A	-	-	D
Freon 115	D	A	A	A	A	-	A	A	-	-	A	-	-	-
Freon 12	D	A	A	B	B	A	B	B	B	B	A	B	-	A
Freon 12 (Wet)	D	-	A	-	A	A	A	-	A	B	A	A	-	-
Freon 13	D	A	A	A	A	A	A	A	A	D	A	A	-	C
Freon 13B1	D	A	A	A	A	-	A	A	A	-	A	-	-	A
Freon 14	D	A	A	A	A	-	D	B	A	-	A	-	-	A
Freon 142B	D	-	-	-	-	-	D	A	D	-	A	-	-	-
Freon 15	C	-	-	-	-	-	-	-	-	-	-	-	-	-

CHEMICAL COMPATABILITY

A: Excellent
B: Good
C: Fair to Poor
D: Not recommended
-: No Data

Chemicals	Metals						Elastomers and Plastics							
	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Freon 152A	D	-	-	-	-	-	A	A	D	-	A	-	-	-
Freon 21	D	A	A	A	A	-	D	D	D	D	A	A	-	-
Freon 218	D	-	-	-	-	-	A	-	A	-	A	-	-	-
Freon 21B	D	-	-	-	-	-	A	-	A	-	A	-	-	-
Freon 22	D	D	D	A	A	A	D	C	D	D	A	B	-	D
Freon 31	D	A	A	A	A	-	D	A	D	-	A	-	-	-
Freon 32	D	A	A	A	A	-	A	A	D	-	A	-	-	-
Freon 502	D	-	A	A	A	-	B	A	B	-	A	-	-	-
Freon Bf	D	A	A	A	A	-	B	D	A	-	A	-	-	-
Freon C316	D	-	-	-	-	-	A	A	A	-	A	-	-	-
Freon C318	D	A	A	A	A	-	A	A	B	-	A	-	-	-
Freon Dry	A	-	B	A	A	-	-	-	-	-	-	-	-	-
Freon Dry F11	D	-	A	A	A	-	B	-	-	D	-	A	-	-
Freon Dry F12, F113, F114	D	-	A	A	A	-	B	-	-	D	-	A	-	-
Freon Dry F21, F22	D	-	A	A	A	-	B	-	-	D	-	A	-	-
Freon K-142B	D	A	A	A	A	-	A	A	D	-	-	-	-	-
Freon K-152A	D	-	-	-	-	-	A	A	D	-	-	-	-	-
Freon K-152K	D	A	A	A	A	-	-	-	-	-	-	-	-	-
Freon Mf	D	A	A	A	A	-	B	D	B	-	A	-	-	-
Freon Pca	D	A	A	A	A	-	A	D	B	-	-	-	-	-
Freon Ta	-	D	-	-	-	-	A	A	D	-	A	-	-	A
Freon Tc	D	-	-	-	-	-	A	B	A	-	A	-	-	A
Freon TF	D	A	A	A	A	A	A	D	B	D	A	B	-	-
Freon Tmc	-	D	-	-	-	-	B	B	A	-	A	-	-	B
Freon T-P35	D	-	-	-	-	-	A	A	A	-	A	-	-	A
Freon T-Wd602	D	-	-	-	-	-	B	B	A	-	A	-	-	A
Freon, BF	D	-	-	-	-	-	-	D	A	-	A	-	-	-
Freon, MF	D	-	-	-	-	-	-	D	D	-	A	-	-	D
Freon, PCA	D	-	-	-	-	-	-	D	B	-	-	-	-	A
Freon, TF	D	-	A	A	-	A	-	D	B	-	A	B	-	B
Glycerin (Glycerol)	A	B	B	A	A	A	A	A	A	A	A	A	A	D
Glycol	B	-	B	B	B	-	A	A	-	A	A	A	A	-
Glycolic Acid	-	-	D	A	A	A	A	A	A	A	A	B	A	-
Glycols	B	-	B	B	B	-	A	-	-	A	A	A	A	-
Gold Monocyanide	-	D	D	D	A	-	A	-	A	-	D	A	-	-
Grape Juice	B	D	D	A	A	-	C	A	A	A	A	A	A	D
Grapefruit Oil	-	D	D	A	A	-	D	-	A	-	A	-	-	-
Grease	A	A	A	A	A	A	A	D	A	-	A	A	-	-
Grease (Ester Base)	A	A	A	A	A	A	-	-	A	A	A	A	-	-
Grease (Petroleum Base)	A	A	A	A	A	A	A	D	A	A	A	A	-	A
Grease (Silicone Base)	A	A	A	A	A	A	A	-	-	A	A	A	-	-
Green Sulfate Liquor	B	-	C	A	-	B	B	A	A	A	A	-	A	A
Halowax Oil	D	-	-	-	-	-	D	D	A	-	A	-	-	-
Heavy Water	A	-	C	A	-	A	-	A	-	-	-	-	-	D
Helium	A	-	A	A	A	-	-	A	A	A	A	-	-	A
Heptanal	A	-	A	A	-	-	A	-	-	A	-	-	-	-
Heptane	A	A	A	A	A	A	A	D	A	D	A	A	A	B

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Hexamine	D	A	A	A	-	-	-	-	-	-	A	-	-	-
Hexanal	A	-	B	A	-	B	D	B	-	-	A	-	-	-
Hexane	A	A	A	A	A	A	A	D	A	C	A	A	C	B
Hexanol	A	-	A	A	-	A	-	A	A	A	A	-	-	D
Hexanol Tertiary	A	A	A	A	A	-	A	-	-	B	A	-	-	-
Hexyl Alchol	A	-	-	A	-	A	A	-	-	A	A	A	A	-
Hexyl Alcohol	A	-	A	A	-	-	A	C	B	-	A	A	C	D
Hexylene Glycol (Brake Fluid)	A	-	A	A	-	A	A	C	A	-	A	-	-	-
Honey	A	A	A	A	A	A	A	A	A	A	A	A	-	-
Hydraulic Oil (Petro)	A	A	A	A	A	A	A	D	A	D	A	A	-	-
Hydraulic Oil (Petroleum Base)	A	A	A	A	A	A	A	D	A	D	A	-	A	-
Hydraulic Oil (Petroleum)	A	-	A	A	A	A	A	D	A	D	A	-	A	-
Hydraulic Oil (Synthetic)	A	A	A	A	A	A	D	D	A	D	A	A	A	B
Hydrazine	B	D	D	A	A	A	C	A	D	D	A	D	-	D
Hydrobromic Acid	D	D	D	D	D	D	D	A	A	C	A	A	A	-
Hydrobromic Acid 20%	D	D	D	D	D	A	D	A	A	A	-	A	-	-
Hydrochloric Acid - 10%	D	D	D	D	D	B	B	A	A	A	A	A	A	-
Hydrochloric Acid - 20%	D	D	D	D	D	D	C	A	A	B	A	A	A	B
Hydrochloric Acid - 30%	D	-	D	D	-	A	C	A	B	B	A	A	C	-
Hydrochloric Acid - 37%	D	D	D	D	D	B	B	C	A	C	A	A	A	D
Hydrochloric Acid - 37% (Cold)	D	-	D	-	D	D	C	-	A	A	A	A	-	-
Hydrochloric Acid - 37% (Hot)	D	-	D	-	D	D	D	-	A	-	A	A	-	-
Hydrochloric Acid 100%	D	D	D	D	D	A	D	D	A	B	A	A	-	-
Hydrochloric Acid, Dry Gas	D	-	-	D	D	A	-	-	-	B	A	A	-	-
Hydrocyanic Acid	A	D	D	B	A	D	C	B	A	A	A	A	A	D
Hydrofluoric Acid	D	D	D	D	D	-	D	C	A	A	A	A	A	-
Hydrofluoric Acid (20%)	D	-	D	-	D	D	D	-	A	A	A	A	-	-
Hydrofluoric Acid (50%)	D	-	D	-	D	D	D	-	A	A	A	A	-	-
Hydrofluoric Acid (75%)	D	-	D	-	D	D	D	-	A	C	A	A	-	-
Hydrofluoric Acid (Conc-) (Hot)	D	-	D	-	D	D	D	-	B	D	A	A	-	-
Hydrofluoric Acid (Conc.)	D	-	D	D	D	D	D	C	A	D	A	A	A	-
Hydrofluoric Acid (Hot)	D	D	D	D	B	-	D	D	-	D	A	A	D	-
Hydrofluoric Acid 100%	D	D	D	D	B	D	D	D	D	D	A	A	-	D
Hydrofluoric Acid 20%	D	D	D	D	D	D	D	D	A	A	A	A	A	D
Hydrogen Sulfide (Wet) (Hot)	D	-	D	-	A	A	D	-	B	A	A	A	-	-
Hydrogen Sulfide Dry	B	B	D	C	A	A	-	A	D	A	A	A	A	A
Hydrolube-Water/Ethylene	A	-	A	A	-	A	-	A	A	A	A	A	-	D
Hydroquinone	B	-	B	B	B	B	D	D	C	A	A	A	A	-
Hydroxyacetic Acid	D	-	B	B	-	-	-	A	D	-	A	-	-	D
Hydroxyacetic Acid — 10%	B	-	-	B	-	-	D	-	-	-	A	-	-	-
Hydroxyacetic Acid 70%	D	B	B	-	-	-	A	A	-	-	A	A	-	-
Hypochlorous Acid	D	D	D	D	D	A	D	B	A	A	A	A	A	D
Ink (Printers)	D	D	D	C	C	A	A	A	A	-	A	A	A	A

CHEMICAL COMPATABILITY

A: Excellent
B: Good
C: Fair to Poor
D: Not recommended
-: No Data

Chemicals	Metals						Elastomers and Plastics							
	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Iodine	D	D	D	D	D	B	B	B	A	D	A	A	B	D
Iodine (in alcohol)	D	-	D	-	D	B	B	A	A	A	A	A	-	-
Iodoform	B	-	A	B	B	D	D	B	A	-	C	C	-	D
Iso Butyl Acetate	A	-	A	A	-	A	-	C	D	-	A	-	-	-
Isoamyl Acetate	A	-	A	A	-	A	D	B	D	-	A	-	-	D
Isoamyl Butyrate	A	-	A	A	-	A	D	-	D	-	A	-	-	-
Isoamyl Chloride	D	-	-	-	-	-	D	D	A	-	A	-	-	-
Isobutyl Acetate	A	-	A	A	-	A	D	C	-	-	A	-	-	-
Isobutyl Alchol	B	-	-	A	-	A	C	-	-	-	A	A	A	-
Isobutyl Alcohol	B	-	C	A	A	A	B	A	A	A	A	A	A	D
Isobutyl Chloride	D	-	B	B	-	A	D	-	B	-	A	-	-	-
Isobutyric Acid	A	-	-	-	-	-	D	A	-	-	A	-	-	-
Isocyanates	-	-	A	A	-	A	-	-	B	A	A	-	-	B
Isododecane	B	-	B	B	-	B	B	D	A	-	A	-	-	B
Isooctane	A	A	A	A	A	A	A	D	A	A	A	A	A	A
Isophorone	A	-	B	A	A	A	D	C	D	-	A	-	-	D
Isopropanol (Isopropyl Alcohol)	A	-	A	A	-	A	-	A	A	A	A	A	-	B
Isopropyl Acetate	D	B	B	C	B	B	D	B	D	B	A	D	C	D
Isopropyl Alchol	B	-	C	A	-	A	C	-	-	A	A	A	A	-
Isopropyl Alcohol	A	A	A	A	A	A	B	B	A	A	A	A	A	D
Isopropyl Amine	-	-	A	A	-	-	D	-	D	-	A	-	-	-
Isopropyl Chloride	D	-	A	A	A	A	D	D	B	D	A	-	-	D
Isopropyl Ether	B	A	A	A	A	A	C	D	D	D	A	D	A	B
Isotane	D	-	-	-	-	A	A	-	A	D	-	A	-	-
Jet Fuel (JP1 to JP6)	A	A	A	A	A	A	A	D	A	D	A	B	-	-
Jet Fuel 120° F - 150° F	-	A	-	-	A	-	-	-	-	D	A	A	-	-
Jet Fuel To 70° F	-	A	-	-	A	-	-	-	-	A	A	A	-	-
Jp-1	A	A	A	A	A	A	A	D	A	D	A	A	A	C
Jp-2	A	A	A	A	A	A	A	D	A	D	A	A	A	C
Jp-3	A	A	A	A	A	A	A	D	A	A	A	A	A	C
Jp-4	A	A	A	A	A	A	A	D	A	A	A	A	A	C
Jp-5	A	A	A	A	A	A	A	D	A	A	A	A	A	B
Jp-6	A	A	A	A	A	A	A	D	A	D	A	A	A	C
Jp-X	A	A	A	A	A	A	A	D	D	D	A	A	A	-
Kerosene	A	A	A	A	A	B	A	D	A	D	A	A	C	B
Kerosene 120°F - 150°F	A	A	-	-	A	-	A	D	A	D	A	A	-	-
Kerosene To 70° F	A	A	-	-	A	-	A	D	A	A	A	A	-	-
Ketchup	-	-	-	A	A	-	A	A	A	-	A	-	-	-
Ketones	B	A	A	A	A	A	D	A	D	D	A	D	C	D
Lacquer Solvents	A	B	B	A	A	A	D	D	D	C	A	D	A	D
Lacquer Thinners	A	C	C	A	A	A	D	D	D	D	A	-	-	-
Lacquers	A	C	C	A	A	A	D	D	D	D	A	D	A	D
Linoleic Acid	A	-	D	B	A	A	B	D	B	B	A	A	A	-
Liquid Petroleum Gas (LPG)	-	-	-	-	-	A	A	D	A	D	A	A	-	C
Lithium Bromide	-	-	A	-	-	-	A	A	A	-	A	A	-	D
Lithium Chloride	D	A	B	A	A	A	A	A	A	A	A	A	D	D
Lithium Hydroxide	D	-	B	B	B	B	C	A	C	A	A	-	D	D

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Lubricants	A	A	A	A	A	A	A	D	A	B	A	A	-	-
Lubricants (Petroleum)	C	-	A	A	A	A	A	D	B	D	A	A	B	B
Lubricating Oil	A	A	A	A	A	-	A	D	A	A	A	A	A	-
Lubricating Oil Di-Ester	A	A	A	A	A	-	B	D	A	-	A	-	A	D
Lubricating Oil SAE 10, 20, 30,	A	-	A	A	-	A	-	D	A	C	A	A	A	A
Lye (Calcium Hydroxide)	C	A	A	B	B	A	A	A	B	A	A	A	-	-
Lye (Potassium Hydroxide)	D	B	B	B	A	B	C	A	B	A	A	A	A	-
Lye (Sodium Hydroxide)	D	D	D	B	B	C	B	B	B	A	A	D	A	-
Lye 10%	D	-	C	B	A	-	A	-	-	-	A	-	-	-
Lye 50%	D	-	C	B	B	-	C	-	-	-	A	A	A	-
Lye Concentrated	D	-	C	B	D	-	B	A	-	A	A	-	-	-
Lye Solutions	-	-	-	A	A	-	C	A	B	A	A	A	A	B
Maganese Chloride	-	-	D	-	-	B	-	C	A	A	A	-	A	B
Magnesium Bisulfate	D	-	-	A	B	-	B	-	-	A	A	-	-	-
Magnesium Carbonate	D	B	B	B	B	B	A	C	A	A	A	A	A	B
Magnesium Chloride	D	D	D	D	D	A	A	A	A	A	A	A	A	-
Magnesium Hydroxide	D	A	B	B	A	A	B	A	A	A	A	A	A	A
Magnesium Nitrate	D	D	D	B	B	B	A	A	A	A	A	A	A	B
Magnesium Oxide	B	A	A	A	A	A	A	A	C	-	A	-	-	-
Magnesium Sulfate	D	B	C	A	B	B	A	A	A	B	A	A	B	D
Maleic Acid	B	A	D	B	B	B	D	D	A	B	A	A	A	D
Maleic Anhydride	A	-	B	A	A	A	D	D	A	D	A	A	-	-
Malic Acid	B	-	D	A	A	B	B	D	A	B	A	A	-	-
Malt Beverages	A	D	D	A	A	-	A	A	A	-	A	-	A	B
Manganese Sulfate	B	A	B	B	B	A	A	A	A	B	A	A	-	-
Maple Sugar Liquors	-	-	-	A	-	-	A	A	A	-	A	-	-	D
Mash	A	-	-	A	A	-	A	A	A	-	-	-	-	A
Mayonnaise	D	D	D	C	A	A	C	D	A	A	A	A	A	D
Melamine	-	D	D	-	D	D	C	A	A	A	A	-	-	-
Melamine Resins	-	-	-	D	-	A	-	A	A	-	A	-	-	D
Mercaptan	-	-	-	-	-	-	-	A	D	-	A	-	-	D
Mercuric Chloride	D	D	D	D	D	B	A	A	A	A	A	A	A	A
Mercuric Chloride (Dilute	D	D	D	D	D	C	A	A	A	B	A	A	-	-
Mercuric Cyanide	D	D	D	C	C	B	B	A	A	B	B	A	A	-
Mercurous Nitrate	D	-	B	B	B	B	B	A	A	A	A	A	A	-
Mercury	D	A	B	A	A	A	A	A	A	B	A	A	A	A
Mesityl Oxide	A	-	A	A	A	A	D	B	D	-	A	-	-	D
Methane	A	-	D	A	A	A	A	D	B	B	A	A	-	C
Methanol	B	A	A	A	A	A	A	A	D	A	A	A	A	D
Methyl Acetate	B	B	B	A	B	A	D	C	D	D	A	B	-	D
Methyl Acetoacetate	-	-	A	A	-	A	D	B	D	-	A	-	-	D
Methyl Acetone	A	A	A	A	A	A	D	A	D	D	A	D	-	-
Methyl Acrylate	-	A	A	A	-	-	D	C	D	D	A	B	-	D
Methyl Alchol (Methanol)	B	-	A	A	-	A	A	D	-	A	A	A	A	-
Methyl Alcohol	B	A	A	B	A	A	A	A	D	A	A	A	A	D
Methyl Alcohol 10%	A	A	A	A	A	A	A	A	C	A	A	A	-	-
Methylamine	B	A	B	A	A	B	B	A	D	A	A	C	-	-

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Methylene Bromide	D	-	A	A	-	A	D	D	C	-	A	A	-	-
Methylene Chloride	D	B	B	B	B	B	D	D	B	D	A	D	D	D
Milk	A	D	D	A	A	A	B	A	A	B	A	A	A	D
Mine Water	B	-	A	B	-	A	A	A	A	A	A	A	A	D
Mineral Oil	A	A	A	A	A	A	A	D	A	C	A	A	C	A
Mineral Spirits	A	B	B	A	A	B	A	D	A	B	A	-	-	-
Mixed Acids	D	D	D	D	D	B	D	B	-	D	A	A	-	-
Molasses	A	B	B	A	A	A	A	A	A	B	A	B	A	B
Monochloroacetic acid	D	D	D	D	B	B	D	C	C	A	D	B	D	D
Monochlorobenzene	D	-	A	B	B	-	D	D	A	D	A	B	B	D
Monochlorodifluoro Methane	D	-	D	A	A	-	-	A	D	A	A	B	-	D
Monoethanolamine	B	B	B	A	B	-	D	B	D	D	A	D	-	D
Morpholine	A	-	A	-	A	A	D	D	-	B	A	D	-	-
Motor oil	A	A	A	A	A	-	A	D	-	C	A	B	-	-
Muriatic Acid	D	D	D	D	D	-	D	C	B	B	A	A	A	-
Muriatic Acid (10%-20% HCL)	D	-	D	D	-	A	-	A	A	A	A	A	A	B
Mustard	B	D	D	D	D	A	C	A	D	A	A	A	A	B
N,N-Dimethyl Formamide	A	-	-	A	-	A	C	-	-	A	A	A	-	-
N,N-Dimethylaniline	B	-	B	-	-	-	D	C	-	D	A	A	-	-
Naphtha	A	B	B	A	A	B	B	D	A	D	B	A	C	C
Naphtha Coal Tar (Benzol)	A	-	B	A	-	A	D	D	-	-	A	-	-	-
Naphthalene	B	A	B	A	B	A	D	D	A	B	A	A	B	B
Naphthoic Acid	B	-	B	A	-	B	B	D	-	-	A	-	-	-
Naptha-Coal Tar (Benzol)	A	-	A	A	-	A	-	D	A	C	A	A	A	B
Napthenic Acid	B	-	B	A	A	B	B	D	A	-	A	-	-	-
Natural Gas	A	A	A	A	A	-	A	D	A	A	A	-	-	C
n-Butyl Acetate	A	-	A	A	-	A	D	D	-	-	A	-	-	-
Neatsfoot Oil	A	-	A	A	A	-	A	C	A	-	A	-	-	A
Neosol	B	-	B	A	-	A	A	B	C	-	A	-	-	-
N-Hexaldehyde	A	-	A	A	A	-	D	A	D	-	A	-	A	B
n-Hexane	A	-	A	A	-	A	A	D	-	C	A	A	B	-
Nickel Acetate	D	-	-	A	-	-	B	A	D	A	A	A	-	D
Nickel Chloride	D	D	D	D	C	B	A	A	A	A	A	A	A	A
Nickel Nitrate	D	C	C	B	B	B	A	A	A	A	A	A	A	A
Nickel Sulfate	D	D	D	B	B	B	A	A	A	A	A	A	A	A
Nitrana (Ammonia Fertilizer)	-	-	-	A	-	-	B	-	C	-	A	-	-	-
Nitrating Acid (<15% HNO3)	D	C	C	C	-	-	-	-	-	C	A	-	-	-
Nitrating Acid (>15% H2SO4)	D	C	C	C	C	A	D	A	-	C	A	-	-	-
Nitrating Acid (S1% Acid)	D	-	-	C	-	-	-	-	-	C	A	-	-	-
Nitrating Acid (S15% H2SO4)	D	A	A	C	-	-	-	-	-	C	A	-	-	-
Nitric Acid - 10%	D	D	D	A	A	A	D	B	A	D	A	A	D	-
Nitric Acid - 20%	D	D	D	A	A	B	D	B	A	B	A	A	A	C
Nitric Acid - 25%	D	D	D	A	A	A	D	B	A	D	A	A	D	-
Nitric Acid - 35%	D	D	D	A	A	A	D	C	A	D	A	A	D	-
Nitric Acid - 50%	D	D	D	B	A	D	D	D	A	D	A	A	D	C
Nitric Acid - 65%	D	-	D	A	-	D	-	D	A	D	A	A	D	C
Nitric Acid - 70%	A	-	D	A	A	D	D	D	B	D	A	A	D	-

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Nitric Acid (5-10% Solution)	D	D	D	A	A	A	D	B	A	A	A	A	A	C
Nitric Acid (Conc.)	D	D	D	A	A	B	D	D	B	D	A	A	D	D
Nitric Acid (Red Fuming)	D	D	D	B	B	B	D	D	B	D	A	D	D	D
Oils: Castor	A	B	B	A	A	A	B	B	A	A	A	A	A	A
Oils: Cinnamon	-	-	D	A	A	-	-	-	A	D	A	-	D	-
Oils: Citric	C	D	D	A	A	-	C	B	A	A	A	-	-	-
Oils: Clove	B	-	D	A	A	A	A	-	A	B	A	-	A	-
Oils: Coconut	B	A	A	A	A	A	B	D	A	A	A	A	A	C
Oils: Cod Liver	B	-	D	A	A	A	B	A	A	A	A	A	A	A
Oils: Corn	B	A	C	B	A	A	D	D	B	A	A	A	A	A
Oils: Cottonseed	B	A	C	C	A	A	C	D	A	A	A	B	B	A
Oils: Creosote	B	-	-	B	B	B	D	D	A	D	A	-	-	-
Oils: Crude	A	-	B	A	A	B	-	D	A	D	A	A	B	D
Oils: Diesel Fuel (20,30,40,50)	A	A	A	A	A	B	A	D	A	B	A	A	-	-
Oils: Fuel (1,2,3,5A,5B,6)	C	A	A	A	A	A	B	D	B	B	A	B	-	-
Oils: Ginger	-	-	D	D	D	A	A	A	A	-	A	A	-	-
Oils: Hydraulic Oil (Petro)	A	A	A	A	A	A	A	D	A	D	A	A	-	-
Oils: Hydraulic Oil (Synthetic)	A	-	-	A	A	A	D	A	A	D	A	A	-	-
Oils: Lemon	C	-	A	A	A	A	C	D	A	D	A	A	-	-
Oils: Linseed	B	A	A	A	A	B	A	D	A	A	A	A	A	B
Oils: Mineral	A	A	A	A	A	A	A	D	A	C	A	A	C	A
Oils: Neatsfoot	A	-	A	A	A	-	A	C	A	-	A	-	-	A
Oils: Olive	A	A	A	B	A	A	D	D	A	A	A	B	A	A
Oils: Orange	A	-	-	A	A	-	A	-	A	A	-	A	-	-
Oils: Palm	B	A	B	A	A	A	B	D	A	A	A	A	A	A
Oils: Peanut	A	A	A	A	A	A	A	D	A	D	A	A	A	B
Oils: Peppermint	D	-	-	A	A	-	D	-	A	B	A	A	C	-
Oils: Pine	A	C	C	A	A	-	D	D	A	D	A	B	C	D
Oils: Rapeseed	-	A	A	A	A	A	D	A	A	D	A	A	D	B
Oils: Rosin	B	-	-	A	A	A	A	-	A	A	A	A	-	-
Oils: Sesame Seed	A	A	A	A	A	-	A	-	A	A	A	A	-	-
Oils: Silicone	B	A	B	A	A	A	A	A	A	A	A	A	A	A
Oils: Soybean	B	A	A	A	A	A	A	D	A	B	A	B	A	B
Oils: Sperm (whale)	-	A	A	A	A	A	A	D	A	A	A	A	-	-
Oils: Tanning	-	-	-	A	A	-	A	-	A	-	-	A	-	-
Oils: Transformer	A	-	B	A	A	A	B	D	A	D	A	A	A	A
Oils: Tung (Wood Oil)	A	A	B	A	B	A	A	D	B	A	A	A	A	C
Oils: Turbine	A	A	A	A	A	-	B	D	A	B	A	A	-	A
Oils: Vegetable	B	B	B	A	A	A	B	D	A	D	A	A	D	A
Oleic Acid	B	B	C	A	A	A	C	D	B	B	A	A	A	-
Oleic Acid (Red Oil)	A	-	C	B	-	A	C	C	A	B	A	A	A	B
Oleum 100% (Fuming Sulfuric)	D	-	D	A	A	D	D	D	B	D	A	D	D	D
Oleum 25%	B	-	-	B	B	A	D	D	A	D	A	C	-	-
Oleum Spirits	D	-	D	B	B	-	C	D	A	D	A	D	A	C
Olive Oil	A	A	A	B	A	A	D	D	A	A	A	B	A	A
Oxalic Acid - 5% (Hot and	B	-	D	B	-	B	-	A	A	A	A	A	A	A

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Oxalic Acid (cold)	D	D	D	D	D	B	D	A	A	A	A	B	A	-
Oxygen	A	B	B	A	A	-	C	A	A	C	A	A	A	-
Oxygen - 200°-400°F	A	-	A	-	A	-	D	-	B	D	A	A	-	-
Ozone	B	D	C	B	B	A	D	A	A	D	A	A	B	A
Paint Thinner, Duco	D	B	B	B	A	A	D	D	B	D	A	-	-	D
Paints & Solvents	D	-	-	A	A	A	-	-	-	-	A	-	-	-
Palm Oil	B	A	B	A	A	A	B	D	A	A	A	A	A	A
Phenol (10%)	A	D	D	B	B	B	D	B	A	B	A	A	-	-
Phenol (Carbolic Acid)	B	D	D	B	B	A	D	C	A	C	A	A	C	-
Phenol Sulfonic Acid	D	-	D	B	B	A	-	-	D	-	A	B	-	-
Phenyl Hydrazine	A	-	D	-	-	-	D	D	A	D	A	D	-	-
Phenyl Sulfonic Acid	B	-	B	B	-	-	D	-	-	-	A	-	-	-
Phosphoric Acid - 10%	D	-	D	A	-	-	A	A	A	A	A	A	A	-
Phosphoric Acid - 20%	D	-	D	A	B	A	C	A	A	A	A	A	A	C
Phosphoric Acid - 45%	D	-	D	-	B	-	D	-	A	A	A	A	-	-
Phosphoric Acid - 50%	D	-	D	A	-	C	D	B	-	A	A	A	A	-
Phosphoric Acid (>40%)	D	D	D	D	D	A	D	B	A	A	A	B	B	D
Phosphoric Acid	D	-	D	A	-	-	D	B	-	A	A	A	A	-
Phosphoric Acid (crude)	C	D	D	D	B	A	D	B	A	B	A	A	-	-
Phosphoric Acid (molten)	C	-	-	-	C	-	D	-	-	D	-	D	-	-
Phosphoric Acid (S40%)	C	D	D	D	C	A	D	B	A	A	A	B	-	-
Phosphoric Acid (To 40%	D	-	D	-	A	A	D	-	A	A	A	A	-	-
Phosphoric Acid Aerated	D	D	D	A	B	-	-	-	-	B	A	A	A	-
Phosphoric Acid Air Free	D	D	D	D	A	-	D	-	-	B	A	A	A	-
Phosphoric Acid Anhydride	C	-	-	-	-	-	-	-	-	A	-	D	-	-
Phosphoric Acid Boiling	D	D	D	D	D	-	-	-	-	A	A	A	D	-
Phosphoric Acid Crude	D	-	D	-	C	A	D	-	A	A	A	A	-	-
Phosphorous Oxychloride	B	-	B	B	-	B	-	-	-	-	A	-	-	-
Phosphorous Trichloride Acid	D	-	B	A	A	A	D	A	A	D	A	A	A	-
Phosphorus	B	A	A	A	A	-	B	-	-	B	A	A	A	-
Phosphorus Pentachloride	-	-	-	-	B	-	-	-	-	B	A	A	-	-
Phosphorus Trichloride	D	-	B	A	A	-	D	A	A	D	A	A	A	-
Photographic Developer	C	D	D	A	A	B	A	B	A	A	A	A	A	B
Photographic Solutions	A	D	D	D	A	B	B	A	B	A	A	B	A	-
Phthalic Acid	B	-	A	B	B	B	D	A	A	B	A	A	A	-
Phthalic Anhydride	A	A	A	A	A	A	D	A	A	D	A	A	-	-
Pickling Solution	-	-	-	-	-	A	-	D	B	-	A	-	A	C
Picric Acid	D	D	D	D	D	D	C	C	A	D	A	A	A	C
Pine Oil	A	C	C	A	A	-	D	D	A	D	A	B	C	D
Plating Solutions - Antimony	D	A	A	A	A	A	A	-	A	A	A	A	A	-
Plating Solutions - Arsenic	C	A	A	A	A	A	A	-	A	A	A	A	A	-
Plating Solutions - Brass	C	A	A	A	A	A	A	A	A	A	A	B	A	-
Plating Solutions - Brass (High-	A	A	A	-	A	A	A	-	A	A	A	B	-	-
Plating Solutions - Bronze	C	A	A	A	A	A	A	A	A	A	A	A	A	-
Plating Solutions - Bronze (Cu-	A	A	A	A	A	A	A	A	A	A	A	A	-	-

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Plating Solutions - Bronze (Cu-	A	A	A	A	A	A	A	-	A	A	A	A	-	-
Plating Solutions - Cadmium	C	-	A	-	A	D	A	-	A	A	A	B	A	-
Plating Solutions - Cadmium	A	A	A	-	A	A	A	-	A	A	A	A	-	-
Plating Solutions - Cadmium	A	D	D	A	A	D	B	-	A	A	A	A	-	-
Plating Solutions - Cadnium	C	-	A	A	-	A	B	B	A	A	A	A	A	-
Plating Solutions - Chrome	D	-	D	A	A	D	D	C	A	A	A	B	A	-
Plating Solutions - Chrome	A	C	C	-	D	D	D	-	C	A	A	C	-	-
Plating Solutions - Chrome	A	A	A	-	C	D	C	-	C	A	A	C	-	-
Plating Solutions - Chrome	A	A	A	-	C	D	D	-	C	A	A	C	-	-
Plating Solutions - Chrome	A	C	C	-	D	D	D	-	C	A	A	C	-	-
Plating Solutions - Chrome	A	C	C	-	C	D	D	-	C	D	A	C	-	-
Plating Solutions - Copper	C	-	A	A	-	D	A	A	A	A	A	B	A	D
Plating Solutions - Cadmium	A	D	D	A	A	D	B	-	A	A	A	A	-	-
Plating Solutions - Cadnium	C	-	A	A	-	A	B	B	A	A	A	A	A	-
Plating Solutions - Chrome	D	-	D	A	A	D	D	C	A	A	A	B	A	-
Plating Solutions - Chrome	A	C	C	-	D	D	D	-	C	A	A	C	-	-
Plating Solutions - Chrome	A	A	A	-	C	D	C	-	C	A	A	C	-	-
Plating Solutions - Chrome	A	A	A	-	C	D	D	-	C	A	A	C	-	-
Plating Solutions - Chrome	A	C	C	-	D	D	D	-	C	A	A	C	-	-
Plating Solutions - Chrome	A	C	C	-	C	D	D	-	C	D	A	C	-	-
Plating Solutions - Copper	C	-	A	A	-	D	A	A	A	A	A	B	A	D
Plating Solutions - Copper	A	D	D	A	D	D	B	-	A	A	A	A	-	-
Plating Solutions - Copper	A	A	A	-	D	D	A	-	A	A	A	A	-	-
Plating Solutions - Copper	A	-	-	-	-	-	D	-	A	A	A	A	-	-
Plating Solutions - Copper	A	A	A	-	A	A	A	-	A	A	A	A	-	-
Polyvinyl Acetate Emulsion	-	-	B	-	-	-	-	A	D	B	A	A	-	-
Potash (Potassium Carbonate)	D	C	C	B	B	B	A	A	A	A	A	A	-	-
Potassium Acetate	D	B	B	B	B	B	B	A	D	A	A	A	A	D
Potassium Aluminum Sulfate	C	-	D	D	B	-	A	-	-	A	A	A	A	-
Potassium Bicarbonate	D	B	B	B	B	B	A	A	A	A	A	B	A	D
Potassium Bichromate	B	-	B	B	B	-	C	-	-	A	A	B	A	-
Potassium Bisulfate	A	-	D	A	-	A	A	-	-	A	A	A	A	-
Potassium Bisulfite	B	-	-	B	-	B	A	A	A	A	A	-	-	A
Potassium Bromide	D	D	D	D	B	B	A	A	A	A	A	A	A	D
Potassium Carbonate (Potash)	D	B	B	B	B	B	A	A	A	A	A	A	A	D
Potassium Chlorate	D	C	C	B	B	B	A	A	A	A	A	A	A	A
Potassium Chloride	D	D	D	C	C	B	A	A	A	A	A	A	A	A
Potassium Chromate	B	B	B	B	B	A	A	A	A	A	A	B	A	B
Potassium Cyanide	D	B	B	B	B	B	A	A	A	A	A	A	A	A
Potassium Dichromate	B	B	B	B	B	B	A	A	A	A	A	A	A	B
Potassium Ferricyanide	B	C	C	B	B	B	D	A	A	A	A	A	A	-
Potassium Ferrocyanide	B	C	C	B	B	B	D	A	A	A	A	A	-	-
Potassium Hydrate	D	-	B	A	-	-	-	-	-	-	A	-	-	-
Potassium Hydroxide	D	B	C	B	A	B	B	A	D	A	A	A	A	B
Potassium Hypochlorite	D	A	D	D	B	B	A	A	D	D	B	B	-	B

CHEMICAL COMPATABILITY

A: Excellent
B: Good
C: Fair to Poor
D: Not recommended
-: No Data

Chemicals	Metals						Elastomers and Plastics							
	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Potassium Iodide	B	A	A	B	A	B	A	A	A	A	A	A	B	-
Potassium Nitrate	B	A	B	B	B	B	A	A	A	A	A	A	A	A
Potassium Nitrite	B	-	B	B	-	B	A	A	-	-	A	-	-	-
Rubber Latex Emulsions	A	-	-	A	-	A	-	-	-	-	A	-	-	-
Rubber Solvents	A	-	-	A	-	A	D	-	-	-	A	-	-	-
Rum	-	-	-	A	A	A	A	A	B	A	A	-	-	D
Rust Inhibitors	-	C	C	A	A	-	A	-	A	A	-	-	-	A
Sal Ammoniac	D	-	D	B	A	A	A	A	A	A	A	A	A	A
Sal Soda	D	-	A	A	-	A	A	A	A	-	A	-	-	-
Salad Dressings	B	D	D	A	A	-	A	D	D	A	-	-	-	D
Salicylic Acid	B	A	D	B	B	A	B	A	A	B	A	A	A	-
Salt Brine	C	D	D	B	D	A	A	A	A	A	A	A	A	-
Salt Water	D	D	D	C	B	A	A	A	A	A	A	A	A	D
Sannic Fluorborate	D	-	D	-	-	-	-	-	A	-	-	-	-	-
Sea Water	D	D	D	C	C	A	A	A	A	A	A	A	A	A
Sea Water (Brine)	A	-	C	A	-	A	A	A	-	A	A	A	A	-
Sesame Seed Oil	A	A	A	A	A	-	A	-	A	A	A	A	-	-
Sewage	D	D	D	A	A	A	A	C	A	A	A	A	A	D
Shellac	A	A	A	A	A	A	-	A	A	A	A	-	D	D
Shellac (Bleached)	A	A	A	A	A	A	A	D	A	A	A	-	-	-
Shellac (Orange)	A	A	A	A	A	-	A	D	-	A	A	-	-	-
Silicone	B	A	A	A	A	-	A	A	A	A	A	A	-	-
Silicone Oil	B	A	B	A	A	A	A	A	A	A	A	A	A	A
Silver Bromide	D	D	D	D	D	-	C	-	-	-	A	-	-	-
Silver Chloride	D	D	D	D	D	-	-	-	-	B	A	-	-	-
Silver Cyanide	D	-	A	A	A	A	-	A	A	A	A	A	A	D
Silver Nitrate	D	C	D	B	B	A	C	A	A	B	A	A	A	A
Skydol 7000	-	-	-	A	-	A	-	A	B	-	A	-	-	D
Skydrol 500	-	-	-	A	-	A	D	A	D	-	A	-	-	D
Skydrol Hydraulic Fluid	-	-	-	A	-	A	D	A	-	-	A	-	-	-
Soap Solutions	D	A	D	A	A	A	A	A	A	A	A	A	A	A
Soda Ash	D	B	B	A	A	A	A	A	A	A	A	A	-	-
Sodium Acetate	B	B	D	B	B	A	C	A	D	A	A	A	A	-
Sodium Acid Sulfate	D	-	C	D	B	-	-	A	A	A	A	-	A	A
Sodium Aluminate	C	A	A	A	A	B	A	A	A	A	A	A	-	-
Sodium Aluminum Sulfate	D	-	D	D	A	B	-	A	A	-	A	-	-	A
Sodium Benzoate	A	-	-	-	-	A	B	A	A	A	A	A	A	-
Sodium Bicarbonate	D	C	C	A	B	B	A	A	A	A	A	A	A	A
Sodium Bichromate	C	-	C	B	B	C	-	A	A	A	A	A	A	A
Sodium Bisulfate	D	D	D	D	C	B	B	A	A	A	A	A	A	A
Sodium Bisulfite	D	D	D	C	B	B	C	A	A	A	A	A	A	A
Sodium Borate	C	-	C	C	B	A	A	A	A	A	A	A	A	-
Sodium Borate (Borax)	C	-	B	B	B	A	A	A	A	A	A	A	A	A
Sodium Bromide	D	C	C	C	C	B	-	A	A	A	A	A	A	-
Sodium Carbonate	D	B	B	A	A	A	A	A	A	A	A	A	A	A
Sodium Chlorate	C	-	B	B	B	B	B	A	A	A	A	A	A	A
Sodium Chloride	C	D	D	C	C	A	A	A	A	A	A	A	A	A
Sodium Chromate	D	A	B	B	B	A	A	-	A	A	A	A	-	-

CHEMICAL COMPATABILITY

A: Excellent
B: Good
C: Fair to Poor
D: Not recommended
-: No Data

Chemicals	Metals						Elastomers and Plastics							
	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Sodium Citrate	-	-	-	B	-	B	-	-	-	-	A	-	A	-
Sodium Cyanide	D	A	B	A	B	A	A	A	A	A	A	A	A	A
Sodium Ferrocyanide	A	-	D	B	B	B	A	A	A	A	A	A	A	-
Sodium Fluoride	B	C	C	D	D	B	A	A	A	A	A	A	A	B
Sodium Hexametaphosphate	C	-	B	B	-		B	B	-	-	A	-	-	-
Sodium Hydrosulfite	-	A	-	-	-		C	B	A	-	A	-	-	-
Sodium Polyphosphate	D	D	D	B	B	A	A	A	A	A	A	A	-	-
Sodium Silicate (Water Glass)	C	B	B	A	B	B	A	A	A	A	A	A	A	B
Sodium Sulfate (Salt Cake)	B	B	B	B	B	B	A	A	A	A	A	A	A	A
Sodium Sulfide	D	C	D	B	D	B	A	A	A	B	A	A	A	A
Sodium Sulfide - Saturated	D	-	B	B	-	A	-	B	B	A	A	A	A	A
Sodium Sulfite	D	A	D	D	B	B	A	A	A	B	A	A	A	A
Sodium Tetraborate	C	-	B	A	A	B	A	A	A	A	A	A	A	B
Sodium Thiosulfate	D	C	D	B	B	B	B	A	A	A	A	A	A	-
Sodium Thiosulphate	B	-	C	-	A	A	B	-	A	A	A	A	-	-
Sodium Triphosphate	B	-	C	A	-	A	-	A	A	A	A	A	-	A
Sorghum	A	A	A	A	A	A	A	A	A	A	-	A	-	-
Soy Sauce	A	D	D	D	D	D	A	A	A	A	A	-	-	B
Soybean Oil	B	A	A	A	A	A	A	D	A	B	A	B	A	B
Stannic Chloride	D	D	D	D	D	B	A	A	A	A	A	A	A	B
Stannic Chloride (Tin Chloride)	D	-	C	A	-	B	A	B	-	A	A	A	-	-
Stannic Fluoborate	D	D	D	-	A	-	A	-	A	A	-	-	-	-
Stannous Chloride	D	A	B	C	A	B	A	C	A	A	A	A	-	C
Starch	B	C	D	B	B	A	A	B	A	A	A	-	A	A
Steam	-	A	A	A	A	A	D	D	D	D	A	D	D	-
Steam 220°F-300°F	A	-	A	-	A	-	D	-	D	-	D	-	-	-
Steam To 200°F	A	-	A	-	A	-	C	-	D	-	D	-	-	-
Stearic Acid	C	C	C	B	B	B	C	B	A	B	A	A	A	A
Stoddard Solvent	A	A	A	A	A	D	B	D	A	C	A	D	-	A
Styrene	A	A	B	A	A	D	D	D	B	D	A	B	A	D
Sucrose Solution	A	-	B	A	-		A	A	A	-	A	-	A	A
Sugar (Liquids)	A	-	A	A	A		A	A	A	A	A	A	A	D
Sulfamic Acid	A	-	-	D	-	D	B	-	-	-	A	-	-	-
Sulfate (Liquors)	D	C	C	B	B	B	A	A	A	A	A	A	-	-
Sulfate Liquor Black	B	-	C	B	B	A	-	A	A	A	A	A	A	A
Sulfate Liquor Green	B	-	C	A	-	A	-	A	A	A	A	A	A	A
Sulfate Liquors	B	-	C	-	C	A	-	-	-	A	-	A	-	-
Sulfite Liquor	D	-	D	B	B	A	B	B	A	B	A	-	A	C
Sulfolane	D	D	D	D	B	-	-	-	-	-	A	-	-	-
Sulfur	D	D	D	D	D	B	D	D	A	B	A	A	A	B
Sulfur Chloride	D	D	D	D	D	B	D	D	A	D	A	A	C	C
Sulfur Dioxide	D	-	D	D	A	C	D	B	D	A	A	A	A	C
Sulfur Dioxide (dry)	B	A	A	D	A	B	D	A	A	A	A	A	-	-
Sulfur Dioxide Gas Dry	D	-	B	A	A	-	D	A	A	C	A	A	A	-
Sulfur Hexafluoride	D	-	D	-	-	D	B	B	C	-	A	-	A	B

CHEMICAL COMPATABILITY

A: Excellent
B: Good
C: Fair to Poor
D: Not recommended
-: No Data

Chemicals	Metals						Elastomers and Plastics							
	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Sulfur Trioxide	D	B	D	B	C	B	D	C	A	D	A	D	C	C
Sulfur Trioxide (dry)	A	A	A	D	C	B	D	C	A	D	A	D	-	-
Sulfuric Acid - (To 75%)	D	-	D	C	-	A	-	C	A	A	A	A	-	D
Sulfuric Acid - 10%	D	-	D	A	-	A	B	A	A	A	A	A	D	-
Sulfuric Acid - 25%	D	-	D	B	-	A	C	B	A	A	A	A	D	-
Sulfuric Acid - 50%	D	-	D	D	-	A	C	B	A	A	A	A	D	-
Sulfuric Acid - 60%	D	-	D	D	-	A	D	C	A	A	A	A	D	-
Sulfuric Acid - 75%	D	-	C	C	-	A	D	C	A	A	A	A	D	-
Sulfuric Acid - 95%	D	-	B	A	-	A	D	C	A	D	A	A	D	-
Sulfuric Acid - Concentrated	-	B	-	-	B	-	D	D	A	B	A	A	D	-
Sulfuric Acid (<10%)	D	C	D	D	C	B	D	A	A	A	A	A	A	D
Tartaric Acid	D	D	D	C	C	B	B	C	A	A	A	B	A	A
Terpene Monocylic	A	-	D	-	-	-	-	D	A	-	A	-	-	-
Terpenes C10	A	-	D	-	-	-	C	D	-	-	A	-	A	-
Terpineol	A	-	A	A	A	A	C	C	A	D	A	B	-	B
Terta Bromoethane	D	-	-	-	-	-	-	D	A	D	A	-	-	-
Tertiary Butyl Catechol	C	-	B	B	B	-	D	-	A	-	A	-	-	-
Tetra Bromomethane	D	-	-	-	-	D	D	-	A	D	A	-	-	-
Tetra Ethyl Lead	A	-	A	A	A	-	B	D	-	D	A	A	-	-
Tetrachloroacetic Acid	D	-	D	D	D	-	-	-	-	-	A	B	-	-
Tetrachloroethane	D	A	B	C	A	A	D	D	A	D	A	A	-	-
Tetrachloroethylene	D	A	A	A	B	-	D	D	A	D	A	A	B	D
Tetraethyl Lead	B	-	A	A	-	-	B	D	A	A	A	A	C	B
Tetrahydrofuran	D	-	A	A	A	A	D	D	D	C	A	C	B	D
Tetrahydronaphthalene	A	-	A	A	-	A	D	D	-	D	A	-	D	-
Tetralin	A	-	A	A	A	A	D	D	A	D	A	-	-	D
Tetraphosphoric Acid	D	-	D	B	B	-	-	-	-	-	A	A	-	-
Thionyl Chloride	D	-	D	D	D	A	D	D	B	D	A	D	D	-
Tin Molten	D	-	-	C	C	-	D	D	D	D	D	D	D	-
Tin Salts	D	-	-	-	D	-	A	B	A	A	A	A	-	-
Tin Tetrachloride	D	-	D	D	D	A	-	-	-	A	A	A	-	B
Titanium Tetrachloride	D	-	B	B	B	B	C	D	A	D	A	B	C	D
Toluene	A	-	A	-	A	A	C	-	A	D	A	A	-	-
Toluene (Toluol)	A	A	A	A	A	A	D	D	C	D	A	A	D	D
Toluene At 70°	A	-	A	A	A	-	D	D	A	D	A	B	C	-
Toluene, Toluol	A	-	A	-	A	-	D	-	A	B	A	A	-	-
Toluidine	A	-	A	A	-	A	D	-	B	-	A	-	-	-
Tomato Juice	A	-	D	A	A	A	A	A	A	A	A	A	A	-
Tomato Pulp & Juice	B	-	-	A	A	A	A	A	A	A	A	A	A	A
Toothpaste	-	-	D	A	-	A	A	-	-	-	A	-	-	-
Transformer Oil	A	-	B	A	A	A	B	D	A	D	A	A	A	A
Transmission Fluid (Type A)	A	A	A	A	A	A	A	D	A	-	A	-	-	A
Triacetin	B	-	-	-	-	-	A	A	D	-	A	-	-	D
Tributyl Phosphate	A	-	B	A	A	-	D	C	D	D	A	A	D	D
Trichloracetic Acid	D	-	D	D	-	B	-	B	D	B	A	A	-	D
Trichlorethylene	D	-	C	-	A	A	D	-	A	B	A	A	-	-
Trichloroacetic Acid	D	D	D	D	D	B	C	C	C	B	A	B	C	-
Trichlorobenzenes	D	-	A	A	-	B	D	-	A	-	A	-	-	D

CHEMICAL COMPATABILITY

Chemicals	Metals						Elastomers and Plastics							
A: Excellent B: Good C: Fair to Poor D: Not recommended -: No Data	Aluminum	Carbon Steel	Cast/Ductile Iron	304 Stainless Steel	316 Stainless Steel	Hastelloy C	Buna - NBR - Nitrile	EPDM - EPR	Viton - FKM	Polypropylene	Teflon - PTFE	PVDF - Kynar	UHMWPE	Urethane
Trichloroethane	D	B	B	B	B		D	D	A	D	A	B	D	D
Trichloroethylene	D	C	C	B	B		D	D	A	D	A	D	C	-
Trichloroethylene (Triad)	B	-	B	B	-	B	-	D	C	C	A	A	-	D
Trichloromono-fluoroethane	A	-	-	A	A	A	-	-	-	-	A	-	-	-
Trichloropropane	D	A	A	A	A	A	D	-	A	D	A	-	-	A
Tricresyl Phosphate	D	-	A	B	B	A	D	A	A	B	A	D	A	D
Tricresylphosphate	D	B	B	B	B	A	D	A	B	B	A	D	-	-
Triethanol Amine	B	-	A	A	A	A	D	B	D	A	A	D	A	D
Triethanolamine	B	-	A	A	A	-	B	A	D	D	A	D	A	-
Triethyl Amine	-	-	A	A	-	A	A	A	A	C	A	A	-	D
Triethyl Phosphate	A	-	A	A	-	-	-	-	-	-	A	D	-	-
Triethylamine	-	A	A	A	A	A	C	A	D	D	A	B	-	-
Trimethylene Glycol	A	-	A	A	-	A	A	A	A	-	A	-	-	-
Triphenyl Phosphite	A	-	C	A	-	-	-	-	-	-	A	-	-	-
Water, Acid Mine	D	D	D	B	B	A	A	A	A	B	A	A	A	C
Water, Boiler Feed	D	-	B	A	-	-	-	-	-	-	-	-	-	-
Water, Brackish	D	-	-	A	A	-	-	-	-	-	A	-	-	-
Water, Deionized	A	D	D	A	A	A	A	A	A	A	A	A	-	-
Water, Demineralized	-	-	-	A	-	-	-	-	-	-	-	-	-	-
Water, Distilled	B	D	D	A	A	A	A	A	A	B	A	A	A	A
Water, Fresh	B	D	D	A	A	A	A	A	B	A	A	A	A	A
Water, Salt	D	D	D	C	C	A	B	A	A	A	A	A	A	B
Water-Brine, Process,	-	D	D	B	B	-	A	A	A	-	D	-	A	D
Waxes	D	-	D	D	A	A	A	D	A	D	A	D	A	A
Weed Killers	D	-	-	A	A	B	B	-	A	-	-	-	-	-
Wemco C	-	-	-	A	-	-	-	D	A	-	A	-	-	A
Whey	B	-	-	A	A	-	A	-	A	-	A	-	-	-
Whiskey	C	-	D	A	A	-	A	A	A	A	A	A	A	-
Whiskey & Wines	D	D	D	A	A	A	B	A	A	A	A	A	A	D
White Liquor (Pulp Mill)	B	C	C	B	A	A	A	A	A	A	A	A	-	D
White Pine Oil	-	-	-	A	-	A	B	D	A	-	A	-	A	A
White Spirit	-	-	-	-	A	-	A	-	-	A	A	A	C	-
White Sulfate Liquor	B	-	C	A	-	B	B	A	-	A	A	A	-	-
White Water (Paper Mill)	-	A	A	A	A	-	-	-	-	-	A	-	-	-
Wine	C	-	D	A	A	A	A	A	-	A	A	A	A	-
Wood Oil	A	-	A	A	-	-	-	D	A	-	A	-	A	C
Wood Pulp	C	-	C	A	-	-	-	-	-	-	A	-	-	-
Wort, Distillery	A	-	B	A	-	A	-	A	A	-	A	-	-	B
Xylene	B	B	B	B	B	A	D	D	B	D	A	A	D	D
Xylidines (Xylidin)	B	-	B	-	-	-	-	D	-	-	A	-	-	-
Zeolite	-	-	-	A	-	A	C	A	A	-	A	-	-	-
Zinc Acetate	C	-	-	A	-	-	C	A	B	A	A	A	A	D
Zinc Carbonate	B	-	B	B	B	B	A	A	A	-	A	-	A	A
Zinc Chloride	D	D	D	D	D	B	B	A	A	A	A	A	A	A
Zinc Cyanide	-	-	-	A	-	-	-	-	-	A	A	-	-	-
Zinc Hydrosulfite	D	D	D	A	A	-	A	A	-	-	A	A	-	-
Zinc Molten	D	-	D	D	D	-	-	-	-	D	D	D	D	-
Zinc Nitrate	-	-	-	A	A	-	-	-	-	A	A	A	-	-
Zinc Sulfate	D	D	D	B	A	B	A	A	A	A	A	A	A	A

GLOSSARY/TERMS

A

ACTUATOR
Device used to operate a valve using electric, pneumatic or hydraulic means. Often used for remote control or sequencing of valve operations.

AGA - AMERICAN GAS ASSOCIATION
A society comprising gas companies set up to achieve common goals.

AIR SET
Another name for a Filter/Regulator.

AISI - AMERICAN IRON AND STEEL INSTITUTE
An association of steel makers which sets standards for the chemical and physical properties of steel and iron in various shapes and forms; pipe, tubing, sheet, strip, wire.

ALLOY STEEL
A steel consisting primarily of iron with some percentage of one or more other elements such as chromium, nickel, manganese, or vanadium deliberately added to enhance its properties.

ALTERNATING CURRENT (AC)
An electric current that reverses its direction at regularly recurring intervals. (Ex. The voltage that you get from the wall outlet in your house.

AMBIENT TEMPERATURE
The prevailing temperature of the environment immediately surrounding an object.

AML - APPROVED MANUFACTURER LIST
A list of the customers approved manufacturers that they will accept.

ANALOG SIGNAL
A signal in which the data is represented or transmitted in continuously varying quantities, as opposed to a digital signal. This is a widely used, yet older technology.

ANGLE VALVE
A variation of the globe valve, in which the end connections are at right angles to each other, rather than being inline.

ANSI - AMERICAN NATIONAL STANDARDS INSTITUTE
The principal standards writing organization in the U.S. who sets standards for a wide variety of items, including the design, fabrication, and testing of pressure piping, systems, and components for various pipeline services.

API - AMERICAN PETROLEUM INSTITUTE
The principal U.S. oil company trade association. It has some standards and specification writing functions, such as well head components and pipeline valves.

ASME - AMERICAN SOCIETY OF MECHANICAL ENGINEERS
This professional society publishes many technical books, papers, codes and standards.

ASTM - AMERICAN SOCIETY FOR TESTING AND MATERIALS
A professional society governing detailed physical and chemical analysis of all basic metals and alloys used in construction. The valves of most manufacturers have components whose materials correspond to ASTM standards.

ATMOSPHERIC PRESSURE
The external pressure exerted on a body by the atmosphere: 14.7 psi (absolute) at sea level.

AUSTENITIC STAINLESS STEEL
The common stainless steel, where the primary micro structure is austenite and the composition primarily iron but also includes both chromium and nickel. The steels are designated as 300 series such as 304,316, CF8M, etc.

B

BACK PRESSURE
Sum total of discharge side, or “downstream” pressures created by cumulative frictions, piping restrictions and elevation impact.

BACK PRESSURE REGULATOR
Regulator designed to control upstream pressure.

BALL CHECK
A valve with a small ball that seals against a seat preventing flow in one direction and allowing flow in the other direction.

BALL VALVE
A valve using a spherical closure element (ball) which is rotated thru 90° to open and close the valve.

BALL
The spherical closure element of a ball valve.

BAR
A metric unit of pressure. One bar equals 14.5 psi.

BBL
An abbreviation for “barrel.” Used to express liquid volume. One barrel of oil is equal to 42 U.S. gallons.

GLOSSARY/TERMS

BELLEVILLE SPRING
A spring resembling a dished washer, used in some ball valves to keep constant pressure on the stem packing to help prolong a leak free system.

BEVEL GEAR OPERATOR
A handwheel gear operator for a gate or globe valve, which by means of a set of bevel gears having the axis of the pinion gear at right angles to that of the larger ring gear.

BLOCK & BLEED VALVE
An isolating valve fitted with an integral bleed connection

BLOCK MOUNT SOLENOID VALVE (NAMUR)
A solenoid valve which is flush mounted to an actuator, i.e., it does not have a pipe nipple or other type of pipe fitting connection.

BLOW DOWN VALVE
A small ball valve that is installed on the aboveground end of an extended drain line. This valve also serves to vent body cavity pressure in the “block and bleed” mode.

BODY
The principal pressure containing part of a valve, in which the closure element and seats are located .

BOLTED BONNET
A bonnet which is connected to a valve body with bolts or studs and nuts.

BOLTING SETS
Bolts, or studs, and nuts sometimes supplied with flanged valves to install the valve between line flanges.

BONNET
The very top of the valve body which fastens (bolts, or threaded) onto the body thereby retaining the internals of the valve and provides the support and stability for the actuation motor (electrical or pneumatic) and accessories. Common on gate and globe valves.

BORE (OR PORT)
The inside diameter of the smallest opening through a valve, e. g., inside diameter of a seat ring, diameter of hole through ball in a ball valve.

BRACKET
A metal component that is used to bolt together the valve and the actuator in an automated assembly. Used with a coupling in a complete mounting kit.

BREAKAWAY TORQUE
Force required to open a valve against pressures acting to keep a valve plug closed.

BUBBLE-TIGHT SHUT-OFF
A phrase used in describing the sealing ability of a valve. During air pressure testing of a new valve in the closed position, leakage past the seats is collected and bubbled thru water. To qualify as “bubble tight,” no bubbles should be observed in a prescribed time span. In reference to a valve, it is zero leakage downstream when the valve is fully closed (Exceeds Class VI shutoff).

BUNA-N (HYCAR, NBR or Nitrile)
Buna-N is a general purpose polymer which has good resistance to oil, water, solvents and hydraulic fluids. It also displays good compression, abrasion resistance, and tensile strength. This material performs extremely well in process areas where paraffin base materials, fatty acids, oils, alcohols or glycerin’s are present, since it is totally unaffected. It should not be used around high polar solvents (acetones, ketones) chlorinated hydrocarbons, ozone, or nitro hydrocarbons. Temperature range is 0°F to 212°F maximum. One substitute for oils at higher temperatures is Viton.

BURIED SERVICE
An application in which valves are installed in lines which are buried below ground level.

BUTT WELD END (BWE)
The end connection of a valve suitably prepared for butt welding to a connecting pipe.

BUTTERFLY VALVE
A short face-to-face valve which has a movable vane or disc, in the center of the flow stream, which rotates 90 degrees as the butterfly valve opens and closes.

BYPASS
A system of pipes and valves permitting the diversion of flow or pressure around a line valve.

GLOSSARY/TERMS

C

CAGE
An internal basket of various designs and functions used in globe style control valves. It might "brace" internal components in place or influence flow patterns while providing guiding surfaces for the plug in high velocity, normally destructive conditions.

CARBON STEEL (CS)
Iron containing carbon in the form of carbides, about 0.1 to 0.3 percent carbon with no other alloying elements other than the sulfur, phosphorus, and other elements present in almost all steels.

CAST IRON
The common term for cast gray iron. Cast iron is brittle, exhibiting very little ductility before fracturing.

CASTING
A product or the act of producing a product made by pouring molten metal into a mold and allowing it to solidify, thus taking the shape of the mold.

CAVITATION
In applications with high pressure drops or with specific series of physical factors, a liquid may partially change from normal liquid phase to a vapor phase and with pressure recovery, revert back to the liquid phase. In this action of individual bubbles imploding, a micro-jet of liquid results which has sufficient force to "blast" or cut away (remove) any material adjacent to the collapsing bubble.

A characteristic sound is as if gravel is bouncing through the pipe and valve components. Very destructive, and to which ball and butterfly valves are especially likely to produce.

CHAIN WHEEL OPERATED VALVE
An overhead valve operated by a chain drive wheel instead of a handwheel.

CHECK VALVE
A one-directional valve which is opened by the fluid flow in one direction and closed automatically when the flow stops or is reversed.

CHEVRON PACKING
A type of packing used in packing boxes consisting of a nest of "V" cross-section rings.

CHOKED FLOW
A condition within a flowing liquid when the pressure drop is sufficient so as to change

the specific liquid into its vapor phase completely, as it passes through the vena contracta, resulting in an inability to increase flow by any further reduction in the downstream pressure. No increase in flow can result without other specific process manipulation.

CLAPPER
The hinged closure element of a swing check valve.

CLEVIS
A "U" shaped connecting yoke at the end of a stem or rod, between the ends of which a gate or other part may be pinned or bolted.

CLASS
A designation of pressure capability. See "ASME," "MWP."

COLD FLOW
Continued deformation or movement of rubber or PTFE under stress.

CONCENTRIC
Having the same centers.

CONDUCTIVITY
Ability to pass current.

CONTAMINANT
A particle or material which is foreign to the fluid media.

CONTROL SIGNAL
Pneumatic signal such as 3-15psi, or electrical signal such as 4-20 mA, 0-10VDC or other international standard with which to translate desired action versus observed state change desired.

CONTROL VALVE
A valve that controls a process variable, such as pressure, flow or temperature by modulating its opening in response to a signal from a controller.

CONTROLLER
A device that measures a controlled variable, compares it with a predetermined setting and signals the actuator to re-adjust the opening of the valve in order to re-establish the original control setting.

CORROSION
The deterioration of a material due to chemical action.

COUPLING
The device that serves to connect the valve shaft and the actuator shaft in an automated assembly. Used with a bracket in a complete mounting kit.

CRYOGENIC TEMPERATURE
Any media at temperature below -292°F (-180°C).

GLOSSARY/TERMS

CRYOGENIC VALVE
A valve capable of functioning at cryogenic temperatures. Commonly these are ball valves and globe valves.

CSA
Abbreviation for Canadian Standards Association counterpart of NEMA and some other American standards and specifications writing bodies and agencies.

CV
Flow coefficient expressed as the number of gallons of water that would flow through an opening, such as a valve port, in 1 minute under a differential pressure of 1 psi. CWP: Cold working pressure – the maximum allowable pressure under non-shock conditions at ambient temperature (-20° F to +100° F).

CYCLE TEST
A procedure whereby a product is put through an interval of time during which a phenomenon is completed. This can be a set number of events or it can be a continuous operation until something in the product fails.

CYCLE
A single complete operation or process returning to the starting point. A valve, stroked from full open to full close and back to full open, has undergone one cycle.

CYLINDER OPERATOR
A power-piston valve operator using either hydraulic or pneumatic pressure.

A sealed piston converts applied pressure into a linear piston rod (stem) motion. Used to operate gate, globe and knife gate valve types.

D

DB / NOISE
Decibels – a measurement unit of sound intensity - Noise level measurements focus on dB intensity / per unit of time. Standards are in place to define relative noise levels for occupational regulations.

Examples:

70 dB is a propeller driven plane passing overhead at 1,000 feet. 80 dB is a garbage disposal unit. A Rock Band 110 dB. Most schools and hospitals have an 85 dB maximum.

DELTA P (^P or ΔP)
See “Differential Pressure,” “Pressure Drop.”

DCS
Distributed Control System. Computer based instrumentation with multiple inputs and outputs for dynamic process control based on operator input requirements for batch or continuous processes. Customers use this system to operate their processes.

DEAD BAND
Range an input can be varied without a change in output.

DIAPHRAGM
A round, thin flexible sealing device secured and sealed around its outer edge - and sometimes around a central hole in the diaphragm - with its unsupported area free to move by flexing.

DIFFERENTIAL PRESSURE
The difference in pressure across a valve in a pressurized line. The difference in pressure between the inlet pressure and outlet pressure of a valve in a pressurized system under flowing conditions.

DIGITAL SIGNAL
A signal in which the data is transmitted or represented by a series of discrete pulses or steps of constant amplitude. This is commonly accepted as a better technology than analog signals and can be referred to as “smart” signals.

DIRECT CURRENT (DC)
An electric current flowing in one direction only and substantially constant in value (Ex. A car battery or AA battery).

DIRECT MOUNT ACTUATOR
The direct mount drive improves actuator positioning, eliminates play, and prevents unwanted side-loading of the stem packing. Eliminates the need for costly mounting brackets and drive couplings and allow for a very low profile valve package.

DISC
The closure element of a globe angle or small regulator valve. The disc (sometimes referred to as a “plug”) moves up and down from the seat in a direction perpendicular to the seat face. Depends on stem force for tight shutoff.

DIVERTING FLOW
In bypass loops or to control excessive flowing medium, it may be controlled with a “diverting” valve to accept all inlet supply, sharing the flow proportionately between two outlet ports (pipes).

GLOSSARY/TERMS

DOUBLE-ACTING (DA)
Pneumatic Actuator which uses air to drive the actuator output shaft in both the open and close direction. The air supply is piped to one side of an actuator, cylinder or diaphragm while the air contained on the opposing side is exhausted. This type of actuator will stay in the same position (fail in last place) until air is provided to the other port/side to move the actuator to the starting position. Power to open, power to close.

DOUBLE BLOCK AND BLEED - DBB
A single valve with two seating surfaces that, in the closed position, provides a seal against pressure from both ends of the valve, with a means of venting/bleeding the cavity between the seating surfaces. A double block-and-bleed valve seals against pressures from both sides of the valve.

DOUBLE ISOLATION AND BLEED – DIB
A single valve with two seating surfaces, each of which, in the closed position, provides a seal against pressure from a single source, with a means of venting/bleeding the cavity between the seating surfaces. A double isolation-and-bleed valve provides an additional seal against pressure from only one side. For applications that require an additional pressure barrier that seals separately from the main pressure barrier, it is important to use a DIB valve instead of a DBB to fulfill operational safety requirements. A DIV valve cannot relieve body cavity pressure past the seats, meaning its seats are not self-relieving.

When using a DIB valve, an external relief system is necessary to relieve pressure buildup.

DPDT SWITCH
Type of electric switch. A DPDT switch routes two separate circuits, connecting each of two inputs to one of two outputs. A DPDT switch has six terminals: two for the inputs, two for the A outputs, and two for the B outputs. A type of limit switch.

DUROMETER
An instrument for determining the hardness of synthetic rubber or elastomeric materials, usually on the “Shore A” scale. Also, the unit of hardness: - i.e., “90 Durometer Shore A.”

DUTY CYCLE
Percentage of real time that a motor is in “powered” motion state as compared to idle.

A motor that is on for 15 seconds and then off for 45 seconds is displaying a 25% duty cycle. It is the allowable percent of electric motor on-time to needed electric motor off-time. Electric motor off-time is necessary to keep the motor from overheating.

E

ECCENTRIC
Not having the same center.

ELASTOMER
A natural or synthetic elastic material often used for O-ring seals. Typical materials are Viton, Buna-n, EPDM (ethylene propylene dimonomer), etc.

ELBOW
A female threaded or socket fitting used for changing direction in a run of pipe or tubing. Commonly provided as 90° and 45°, though others are available. Also see “Street Ell.”

ELASTOMER
Any of various elastic substances resembling rubber.

ELECTRIC ACTUATOR
An electro-mechanical device used to open and close or modulate a valve. The actuator (which is mounted and coupled to the valve in similar fashion as the pneumatic actuator), operates the valve using an electric motor driving a gear train.

ELECTRIC FAIL SAFE ACTUATOR
Electrically driven actuator that contains an internal spring or other device to close the valve on loss of electricity.

ELECTRO-PNEUMATIC POSITIONER
Commonly shown as E/P. It contains an I/P (I to P), which means current-to- pressure. Normal range is 4 to 20 mA. It converts the incoming 4 to 20 mA signal to 3 to 15 PSI output signal, internally, which modulates or throttles the valve/actuator.

ELECTROLESS NICKEL PLATING
A plating process which requires no external electrical power and is the result of a chemical reaction between the part and the plating solution.

EMERGENCY SHUT DOWN VALVES
A valve or a system of valves which, when activated, initiate a shut-down of the plant, process, or platform they are tied to.

END CONNECTION
The type of connection supplied on the ends of a valve which allows it to be installed in a pipeline. Socket Weld (SW), raised face flange (RF), ring type joint (RTJ), screwed end (SE), or Butt Weld (BW).

GLOSSARY/TERMS

END TORQUE
The torque required to overcome resistance at the end of the actuators stroke.

EPDM
EPDM is a terpolymer elastomer made from ethylene-propylene diene monomer. EPDM has good abrasion and tear resistance and offers excellent chemical resistance to a variety of acids and alkalines. It is susceptible to attacks by oils and IS NOT recommended for applications involving petroleum oils, strong acids, or strong alkalines. EPDM should not be used on compressed air lines. It has exceptionally good weather aging and ozone resistance. Temperature rating is from -20ºF to +250ºF . It is fairly good in ketones and alcohols.

EQUAL PERCENTAGE
Double the amount of opening at regular increments of stem position change. OR in other words Equal increments of travel gives equal percentage change.

EXPANDING GATE VALVE
A gate valve that is comprised of a separate gate and segment that as the valve operates the gate and segment move without touching the seats, permitting the valve to be opened and closed without wear. In the closed position the gate and segment are forced against the seat. Continued downward movement of the gate causes the gate and segment to expand against the seats. When the valve reaches its full open position, the gate and segment seal off against the seats while the flow is isolated from the valve body.

EROSION
The mechanical wearing away of a metal surface or part due to fluid impingement. The presence of entrained solid particles accelerates this process.

EXPLOSION PROOF
The prevention of explosion, triggered by electrical components, through containment in special housings. Requirements for electrical devices; electric actuators, solenoids and limit switches, when exposed to a potentially explosive environment. An Enclosure strong enough to contain internal sparks or ignition of gases present internally, and to effectively cool the rapidly expanding hot gases from an internal explosion enough to guarantee that external surrounding areas containing explosive vapors cannot be ignited.

EXTERNAL COATING
Coating applied to protect valves against various environments - sea air, salt water, earth buried, normal air exposure.

F

F.O.B. - FREE ON BOARD / FREIGHT ON BOARD
Transportation charges are absorbed by vendor to the F.O. B. point. Usually shipment is F.O.B. factory. In which case, title and transportation charges pass to the customer when shipment leaves the factory.

FACE-TO-FACE
The overall dimension from the inlet face of a valve to the outlet face of the valve (one end to the other). This dimension is governed by ASME B16.10 and API-6D to ensure that such valves are mutually inter changeable, regardless of the manufacturer.

FAIL CLOSED
(Spring Return) The actuator would mechanically spring the valve to the closed position upon loss of air or electric. In this case, the valve would close. Commonly requirements for spring return actuators.

FAIL OPEN
(Spring Return) The actuator would mechanically spring the valve to the open position upon loss of air or electric. In this case, the valve would open. Commonly requirements for spring return actuators.

FAIL SAFE VALVE
A valve designed to fail in a preferred position (open or closed) in order to avoid an undesirable consequence in a piping system.

FIRE SAFE
A valve that will contain its media even if it is in a fire. It prevents the media from leaking through the sealing device, the stem and body sections. API Spec 607/6FA is generally recognized for fire safe valves.

FEEDBACK
Feedback is information that is sent from a remote or non-accessible device that can be viewed elsewhere.

GLOSSARY/TERMS

FEEDBACK POTENTIOMETER
A variable resistor which gives the ability to provide position indication throughout the entire valve/actuator stroke. When used in an actuator as a position sensor, a potentiometer may be directly attached to the output shaft or indirectly by any acceptable means. As the valve changes position, the actuator output shaft turns thus changing the resistance of the potentiometer. This changing resistance is then made available to any desirable or acceptable electrical circuit for position control.

FEMALE THREAD
An internal screw thread designed to mate with a component having male (external) threads of the same size and type.

FIELDBUS
All Digital, bidirectional, multi drop communications system.

FIELD SERVICEABLE
A statement indicating that normal repair of the valve or replacement of operating parts can be accomplished in the field without return to the manufacturer.

FILTER/REGULATOR
A device which may be used to protect pneumatic equipment by removing up to 99% of the condensed water from the air supply, and by filtering out dust, rust and pipe scale. It also is used for regulating or controlling air pressure from some higher pressure to a desired lower pressure level.

FIRE SAFE
A statement associated with a valve design which is capable of passing certain specified leakage and operational tests after exposure to fire. Must be referenced to a particular specification. See API Spec. 6FA and BS Spec 6755.

FITTING
Any component, other than valves, used with pipe as part of the pressure system and normally referring to items covered by a national standard.

FLANGE
A cast or formed pipe fitting consisting of a projecting radial collar with bolt holes to provide means of attachment to piping components having a similar fitting. The end piece of flanged-end valves.

FLAT FACE (FF)
A flange surface in which the gasket sealing area is the entire surface from the ID to the outside edge. Usually used for class 125 cast iron valves. Used in conjunction with Full Face gaskets.

FLOAT VALVE
A valve which automatically opens or closes as the level of a liquid changes. The valve is operated mechanically by a float which rests on the top of the liquid.

FLOATING BALL VALVE
The standard type of ball valve that allows the ball to “float”. When the valve is closed, the ball “floats” into the downstream seat to make a positive shut-off.

FLOW COEFFICIENT
Cv is defined as the flow in U.S. gallons of water (at 60°F) that will pass through the valve in one minute with a differential pressure across the valve of 1 PSI.

FLOW RATE
The volume of a fluid, gas or steam passing through a pipeline per unit of time (Ex. 500GPM of water, 3000 SCFM of nitrogen or 350 lbs/hr of steam).

FM
Stands for Factory Mutual Engineering Corporation. It is an independent American company that specializes in testing and approving certain products that may be used in hazardous applications involving fuel oil and gases.

FORCE
The intensity of an influence tending to produce motion, distortion or change of shape. The product of unit force (PSI) and the area over which it acts.

Usually expressed in pounds.

FORGING
A metalworking process that involves hammering or squeezing, with or without a die, at hot working temperatures to form a specific shape.

FOUR-WAY SOLENOID VALVE
A solenoid valve having four/five pipe connections, one pressure port, two cylinder ports and one/two exhaust ports. They are commonly used with double-acting actuators.

By applying an electric voltage, pressure is applied to one side of the actuator. When the electric voltage is removed, it supplies pressure to the other side of the actuator.

GLOSSARY/TERMS

FRICTION
The resistance to motion between two contacting surfaces or substances. Friction is also developed between a flowing fluid and the inner wall of the conducting pipe - resulting in a drop in pressure.

FULL BORE (FULL PORT)
Describes a valve in which the bore (port) is nominally equal to the bore of the connecting pipe.

FULL OPENING
Describes a valve whose bore (port) is nominally equal to the bore of the connecting pipe.

FULL PORT (FULL BORE)
Describes a valve in which the port (bore) is nominally equal to the bore of the connecting pipe.

FULL RANGE ADJUSTABLE STOPS / 100% TRAVEL STOP ADJUSTMENT
A mechanical means for adjusting the amount of travel at any point through the full range of the valve/actuator travel.

G

GAS
A compressible fluid - such as air, hydrogen, nitrogen, etc.

GASKET
A component whose purpose is to seal a joint between two larger components, softer than the surfaces of the joint being sealed and usually squeezed by means of bolting to affect the seal. Used to connect flanges, or to seal a bonnet to a valve body.

GATE VALVE
A straight-thru pattern valve whose closure element is a wedge or parallel-sided slab, situated between two fixed seating surfaces, with means to move it in or out of the flow stream in a direction perpendicular to the pipeline axis.

GLAND FOLLOWER OR GLAND FLANGE
The component used to hold down or retain the gland in the stuffing box.

GLAND OR GLAND BUSHING
That part of a valve which retains or compresses the stem packing in a stuffing box (where used) or retains a stem O-ring, lip seal, or stem O-ring bushing.

Sometimes manually adjustable. See “Packing,” “Stuffing Box.”

GLAND PLATE
The plate in a valve which retains the gland, gland bushing or stem seals and sometimes guides the stem.

GLOBE VALVE
A valve whose closure element is a flat disc or conical plug sealing on a seat which is usually parallel to the flow axis. Can be used for throttling services.

GEAR OPERATED
The actuation of a valve thru a gear set which multiplies the torque applied to the valve stem.

GRAPHITE
Flexible carbon material used to make gaskets and packing. This material is used for steam service, higher temperatures and fire safe applications.

GREASE FITTING
A fitting through which lubricant or sealant is injected.

H

HAND WHEEL
A wheel-shaped valve operating device intended to be grasped with one or both hands which allows turning the valve stem or operator shaft to which it is attached.

HARD FACING
A surface preparation in which an alloy is deposited on a metal surface usually by weld overlay to increase resistance to abrasion and or corrosion.

HEAT TREATMENT
Describes any process or procedure by which the internal structure of steel is altered by heating to produce desired physical characteristics. This is usually accomplished by furnace heating followed by controlled cooling.

HEATER
In reference to electric actuators, it is basically a resister which produces heat by converting electrical energy into heat. Used as anti-condensation to remove the possibility of moisture inside of the electric actuator.

HERMETIC SEAL
A permanent seal created by fusion, soldering, welding, brazing or other means, to prevent the transmission of gases. A hermetic seal is also referred to as “helium tight,” “leak tight,” or “vacuum tight.”

HOT TAP
A connection made to a pipeline while the line is under pressure or in service.

GLOSSARY/TERMS

A special procedure is required to make an opening in the pipe without leaking any of the line contents.

HANDWHEEL OPERATED
A valve on which the handwheel drives the stem directly, or through a gear operator to operate the valve.

HUNTING
With either continuous process upset conditions or with improper PID settings, a control valve can exhibit a constant increasing and decreasing stroke, never settling to a constant. A process will coincidentally experience an overshooting and then an undershooting of the desired control point. This can happen if the calibration of the positioner or the positioner card in an electric actuator is not correct. It causes the package to change positions and not find a steady position.

HYDRAULIC MOTOR ACTUATOR (OPERATOR)
A device by which rotation of a hydraulically powered motor is converted into mechanical motion.

HYDRAULIC
Pertaining to, or using, water, oil, or other liquids.

HYDROSTATIC TEST (SHELL TEST)
A test in which a valve is completely filled with water and pressure tested. Used for conducting proof pressure testing.

HYSTERESIS
Happens when parts do not fit tightly together and a “sloppiness” occurs in the positioning of the valve.

I

IBBM
Iron body, bronze mounted - common term for valves with cast iron body and bonnet and bronze trim (seating surfaces, stem, bushings).

I.D.
The measurement of the inside diameter of a circular part.

INLET PORT
That end of a valve which is connected to the upstream (high) pressure zone of a fluid system.

INTRINSICALLY SAFE
Power levels are sufficiently low so as to not be able to ignite a hazardous (explosive) atmosphere Intrinsic safety may be attained through integral circuitry or an appropriately sized barrier, both of which are current limiting devices. The on-board circuitry, or barrier, is designed for the area classification which the monitoring device is to be used. The basis of intrinsic safety is to limit the amount of current through a device, so that if there is exposure to the surrounding atmosphere, there is not sufficient heat generated to ignite that atmosphere.

ISO (INTERNATIONAL STANDARDS ORGANIZATION)
An organization which sets minimum international standards for a wide variety of items manufactured and used in pipeline services.

ISRS – INSIDE SCREW, RISING STEM
Common term for any valve design in which the stem threads are exposed to the fluid below the packing and the stem rises up through the packing when the valve is opened.

J

JACKSCREW
A type of manual override. Specifically, it is a threaded rod assembled such that it pushes on the pneumatic actuator piston. Common on scotch-yoke actuators as a manual override.

L

LEAKAGE
Term often used to describe either stem leakage in case of compromised packing often seen as pooling of liquids collect, or may also be used to describe seat leakage. In such cases it may be the result of wire drawing, age or erosive damage to the close off components.

LEAKAGE / CLASS
ANSI bodies have defined a leakage in units of percent of maximum rated Cv for Classes IV, V and VI. Refer to these standards for current definitions.

GLOSSARY/TERMS

Example: Class IV is metal seated and has more leak through than Class VI which leaks the least under ANSI standards. Some manufacturers use the term “bubble tight” to indicate a leakage that is better than Class IV.

LEVER
A handle type operating device for quarter-turn valves.

LIMIT SWITCH / END SWITCH
An electrical device providing a signal to a remote observation station indicating when the valve is in the fully open or fully closed position. Usually mounted to a valve actuator.

A limit switch is used as a limit indicator, it signals the valve position, usually the on (or full open) position or the off (or full closed) position. It may also be set to indicate any desired position between full open and full closed. Switches are located inside enclosures.

A device used to allow a customer to remotely determine if an on/off valve assembly is in the open or closed position. Customers will wire electric to this switch to light a light, set an alarm, or any other indication that they want.

LINEAR ACTUATOR
This is an actuator (pneumatic or hydraulic) that operates Linear-motion valves (also commonly called linear valves). Gate, globe, pinch, diaphragm, knife gate and angle valves all fit into this classification.

LINEAR FLOW
Equal increments of control signal change resulting in equal flow percentage changes. 100% of flow to 100% of stroke. At 50% of stroke, it will experience 50% of flow capacity. Increase flow with valves opening in direct proportion to the signal applied to the actuator. Other than temperature loops operate best with linear flow characteristics.

LNG - LIQUEFIED NATURAL GAS
Natural gas in the liquid state. To remain liquefied, the temperature must be maintained in the cryogenic region. The liquid occupies far less volume than an equivalent volume of gas, and it can be readily transported by ship and stored a shore in insulated tanks to await re-gasification.

LOCKING DEVICE
A mechanism provided on valve operators to prevent unauthorized operation or tampering.

LPG - LIQUID PETROLEUM GAS
Gases such as butane or propane in the liquid state. LPG, under relatively low pressure, remains a liquid at normal ambient temperature.

LUBRICATED PLUG VALVE
A type of plug valve that uses an injected grease as a sealant when the valve is closed. Typically used in natural gas service.

M

MALE THREAD
The external thread on pipe, fittings or valves used in making a connection with mating female (internal) threaded parts.

MANUAL GEAR OPERATOR
A gear operator that is operated manually (with a handwheel).

MANUAL OVERRIDE
Any device which is used to operate a valve/actuator unit without using the primary supply power source. A manual override must overcome both the valve torque and the actuator static torque.

MAOP/MAWP
Maximum allowable operating (working) pressure. Determined in accordance with piping codes, DOT regulations, etc.

MASTER VALVE
The valve in a three-way assembly on which the actuator is mounted.

MATERIAL TEST REPORTS
Certificates provided by the steel manufacturer indicating the chemical analysis and mechanical properties of a specific batch of steel traced by sequentially assigned heat numbers or codes.

MAXIMUM-SHUT-OFF PRESSURE
The pressure of the media flowing into the valve against which the valve will have to close.

MDS/MSDS - MATERIAL DATA SHEET
The material data sheet defines the minimum requirements for the required materials, i.e., chemical requirements, manufacturing, qualification of supplier, mechanical testing and properties, non-destructive examination, repair, marking, and certification.

MEDIA
The material flowing through the valve.

GLOSSARY/TERMS

METAL-TO-METAL SEAL
The seal produced by metal-to-metal contact between the sealing face of the seat ring and the closure element, without benefit of a synthetic seal.

METER PROVER
A system used to check or "prove" a flow meter. A close fitting sphere is launched into a pipe of known inside diameter. The flow medium pushes the sphere thru a measured length of pipe between two sphere detection devices. Knowing the transit time and the exact volume between the two stations, a flow rate is calculated and compared with the meter reading.

METER RUN
A section of pipeline in which a meter is installed to measure the volume of fluid passing thru the line.

MIXING FLOW
Converse to diverting, the operation in a mixing valve is to accept two differing flowing input sources and mix them proportionately according to a control signal from 100% of one (upper) and 0% of the other (lower), changing gradually as signaled, to the opposite extreme, 0% of one (upper) and 100% of the other (lower).

MOV - MOTOR OPERATED VALVE
A valve with an electric actuator.

MOTOR BRAKE
The name suggests the function braking or stopping the turning action or effort of electric motors in the enclosure of an electric actuator. This is a requirement for all electrically automated butterfly, high performance butterfly and Triple Offset Valves. It is also recommended for 3" and larger flanged ball valves.

MODULATING SERVICE
Proportional positioning of a valve between the open and closed position. Used for flow control processes.

MSS - MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTING INDUSTRY
A technical association of valve, fitting and actuator manufacturers that writes standards and practices for the valve and fittings industry. Recommendations of this society are advisory only.

MTR - MATERIAL TEST REPORTS
Certificates provided by the steel manufacturer indicating the chemical analysis and mechanical properties of a specific batch of steel traced by sequentially assigned heat numbers or codes.

MULTI-TURN VALVE / ACTUATOR
A valve or actuator which requires more than one 360° rotation to complete its full travel.

MWP - MAXIMUM WORKING PRESSURE OR CWP - COLD WORKING PRESSURE
The maximum working pressure (pounds per square inch) at which a valve can be operated. The maximum working pressures for various pressure classes, (Table 2.1 of API-6D, within temperature limits of -20°Fand +100°F).

N

NACE - NATIONAL ASSOCIATION OF CORROSION ENGINEERS
This technical association publishes papers, articles and standards on all aspects of corrosion, and has written the definitive standards for valve materials for sour gas service.

NAMUR
International Standards for actuator interfaces mounting connections for Solenoid Valve connection, Limit Switches and Positioners.

NAMUR BLOCK MOUNT SOLENOID VALVE
A solenoid valve which is flush mounted to an actuator, i.e., it does not have a pipe nipple or other type of pipe fitting connection.

NDE - NON-DESTRUCTIVE EXAMINATION
See "Non-Destructive Tests."

NEEDLE VALVE
A type of small valve, used for flow metering, having a tapered needle-point plug or closure element and a seat having a small orifice.

NEMA - NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
An association which has set up guidelines for the manufacture of electrical equipment. Generally applicable to specifications for switches, etc., for electric operators.

GLOSSARY/TERMS

NEMA 4 WATER TIGHT & DUST TIGHT - INDOORS/OUTDOORS
Type 4 enclosures are intended for general purpose indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose directed water; and to be undamaged by the formation of ice on the enclosure.

NEMA 4X WATER TIGHT, DUST TIGHT, & CORROSION RESISTANT - INDOORS/OUTDOORS
Type 4X enclosures are intended for general purpose indoor and outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, and hose-directed water; and to be undamaged by the formation of ice on the enclosure.

NEMA 6 SUBMERSIBLE, WATER TIGHT, DUST TIGHT, & ICE/ SLEET RESISTANT - INDOORS/ OUTDOORS
Type 6 enclosures are intended for general purpose indoor or outdoor use primarily to provide a degree of protection against the entry of water during temporary submersion at a limited depth; and to be undamaged by the formation of ice on the enclosure.

NEMA 7 UNDERWRITERS LAB CLASS 1-GROUPS C&D -EXPLOSION PROOF - INDOORS
Type 7 enclosures are for indoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the National Electrical Code. Type 7 enclosures shall be capable of withstanding the pressures resulting from an internal explosion of specified gases, and contain such an explosion sufficiently that an explosive gas-air mixture existing in the atmosphere surrounding the enclosure will not be ignited. Enclosed heat generating devices shall not cause external surfaces to reach temperatures capable of igniting explosive gas-air mixtures in the surrounding atmosphere. Enclosures shall meet

explosion, hydro-static, and temperature design tests.

NEMA 9 UNDERWRITERS' LAB CLASS II - GROUPS E,F,G - INDOORS
Type 9 enclosures are intended for special purpose indoor use in locations classified as hazardous (Class II, Groups E, F, or G, as defined in the National Electrical Code). Type 9 enclosures shall be capable of preventing the entrance of dust. Enclosed heat generating devices shall not cause external surfaces to reach temperatures capable of igniting or discoloring dust on the enclosure or igniting dust-air mixtures in the surrounding atmosphere. Enclosures shall meet dust penetration and temperature design tests, and aging of gaskets.

NIPPLE
A short length of small size pipe threaded on both ends. Used on end connections of screwed-end valves and in small size piping systems.

NITROGEN/HELIUM TEST
A pressure test conducted using nitrogen or helium (inert gases) instead of air, water, or other gases to prevent any dangers of fires or explosions. Generally specified by the purchaser when buying a valve or regulator product.

NON-DESTRUCTIVE TESTS
Those inspection tests which are not destructive to the valve structure or function. See "Radiographic Inspection" and "Ultrasonic Inspection."

NON-INCENDIVE
Non-incendive equipment contains components that do not allow arcs or sparks to ignite concentrations of flammable gases. One method of producing a non-incendive switch is by sealing off the contact chamber with a hermetic seal so that a flammable gas cannot enter into the arcing/sparking area of the switch.

NON-RISING STEM
A gate valve having its stem threaded into the gate. As the stem turns, the gate moves, but the stem does not rise. Stem threads are exposed to line fluids.

NORMALLY CLOSED
Describes the normal operating position of a valve. Obviously, in this case the valve would be closed.

NORMALLY OPEN
Describes the normal operating position of a valve. Obviously, in this case the valve would be open.

GLOSSARY/TERMS

NORMALLY CLOSED SOLENOID VALVE
An electrically operated valve whose inlet orifice is closed when the solenoid coil is not energized. Energize to open.

NORMALLY OPEN SOLENOID VALVE
An electrically operated valve whose inlet orifice is open when the solenoid coil is not energized. Energize to close.

NPS: NOMINAL PIPE SIZE
Dimensionless number used to indicate sizes of pressure pipe and valves - used interchangeably with valve size in inches.

NPT - NATIONAL PIPE TAPER
Standard tapered thread for pressure pipe and components. Requirements defined in ASME B1.20.1.

NRS - NON-RISING STEM
A gate valve having its stem threaded into the gate. As the stem turns the gate moves but the stem does not rise. Stem threads are exposed to the line fluid.

O

O.D. - OUTSIDE DIAMETER
The measurement of the outermost diameter of a circular part.

ON-OFF SERVICE
When the valve is being used to start or stop flow by being cycled to the full open or full closed position.

OPERATING PRESSURE
The pressure at which system functions. Also known as working pressure.

OPERATING TIME
The time required for a power operator to stroke the valve from the full open to full closed position, or vice-versa.

OPERATOR
A device which converts manual, hydraulic, pneumatic or electrical energy into mechanical motion to open and close a valve.

O-RING
An elastomeric or synthetic seal ring of circular cross-section.

OS&Y - OUTSIDE SCREW AND YOKE
A valve in which the fluid does not come in contact with the stem threads. The stem sealing elements is between the valve body and the stem threads.

P

P&ID
Piping and Instrument Drawing showing piping, valves, pumps and other components that a customer wants built/installed.

PACKING GLAND
See “Gland.”

PACKING
The deformable sealing material inserted into a valve stem stuffing box, which, when compressed by a gland, provides a tight seal about the stem. See “Gland”; “Stuffing Box.”

PEEK
“Poly Ether Ketone” - a class of thermo-plastic organic polymer with superior mechanical strength and temperature reliance up to 662 degrees F. Used for its superior “soft seat” capability for Class VI “bubble tight” close off also very reliable for internal bearings due to the superior resistance to chemical and thermal degradation.

PIG
A device, closely conforming to the pipe bore, which is forced thru a pipeline to clean the pipe of all foreign material and debris. The valves in a pipeline that will be pigged, must be thru-conduit or full port, otherwise the pig will not pass through them.

PILOT-OPERATED REGULATOR
A regulator which is controlled by a second small volume high accuracy regulator or pilot. This arrangement has the advantages of improving performance by minimizing the effects of unbalance and droop.

PINION SHAFT
The input shaft inside of a rack & pinion actuator. The shaft is typically centered in the actuator housing and the pistons rotate the shaft clock-wise (CW) or counter clock-wise (CCW). The bottom of the shaft connects to the valve stem or the coupling. The top of the shaft is connected to limit switches or positioners.

PITCH AND LEAD
Pertaining to screw threads. The pitch refers to the measurement between adjacent threads. The lead refers to the distance the screw advances in one complete revolution.

GLOSSARY/TERMS

PLC
Programmable Logic Controller. A device which compares desired process conditions to actual state and provides output signal changes to effect a change

PLUG VALVE
A quarter turn valve whose closure element is usually a tapered plug having a rectangular port.

PLUG
The rotating closure element of a plug valve. Also, a threaded fitting used to close off and seal an opening into a pressure containing chamber, e.g., pipe plug.

PMI - POSITIVE MATERIAL IDENTIFICATION
A method for cross checking the identity of a piece of material, often using a portable spectrometer, usually with x-rays (TN 9266, nuclear analyzer) or a welding arc (Arc Met 900, optical spectrometer).

PNEUMATIC
Pertaining to, or using, air or gas.

PNEUMATIC SIGNALS
Standard air signals may be 3-15 psi, 1-17 psi, 0-30 psi depending on the "work" required, and the instrument normally relied on to provide the signal.

POLE
On a switch, it defines how many separate circuits the switch can control. A switch with Single pole, can only influence one single circuit. A Double Pole switch can separately control two different circuits.

POROSITY
A defect found in castings or welds consisting of gas bubbles or voids in the solidified metal.

PORT (BORE)
The inside diameter of the smallest opening through a valve, e. g., inside diameter of a seat ring, diameter of hole through ball in a ball valve.

POSITION INDICATOR
Any external device which visually indicates the open and closed position of a valve. See "Stem Indicator."

POSITIONER
A device, which accepts a remote signal (input) and compares it to the feedback indication it collects from the valve (stem usually) and adjusts the output, either pneumatic or electric to "position" the stem to the desired stroke orientation.

PRESSURE CLASS
A pressure rating expressed as a dimensionless number. The class rating charts give actual pounds per square inch maximum allowable pressure at a given temperature.

PRESSURE DIFFERENTIAL
The difference between inlet and outlet pressures in a given situation – flowing or closed.

PRESSURE DROP
The decrease in pressure along the direction of flow in a piping system, caused by fluid friction, restrictions, and by change-of-direction fittings. Pressure drop is related to velocity, specific gravity, viscosity and to the size and roughness of the pipe interior. See "Differential Pressure."

PRESSURE GAUGE
An instrument, usually with a threaded connection, for measuring and indicating the pressure in a piping system at the point at which it is connected.

PRESSURE SWITCH
A switch (usually electric) activated by a rise or drop in pressure.

PRESSURE TEST
A test using specified pressures of liquid or gases, which can be used to check sealing, integrity, design standards, etc. of a particular product.

PRESSURE-TEMPERATURE RATINGS
The maximum allowable working pressures at specified temperatures. For steel valves, the ratings are defined by "classes" and found in ASME B16.34. For iron and bronze valves, the ratings are defined in the applicable MSS specifications.

PROXIMITY SWITCH
A position switch which is operated without mechanical contact with a moving target.

PSI (PSI) - POUNDS PER SQUARE INCH
Force per unit area exerted against a resisting body.

PSIG
Pounds per square inch gauge.

GLOSSARY/TERMS

PTFE (TFE, VTFE, VIRGIN TEFLON OR TEFLON®)
PTFE is the most chemically resistant of all plastics. It also has excellent thermal and electrical insulation properties. PTFE's mechanical properties are low compared to other engineering plastics, but its properties remain at useful levels over a great temperature range (-40 to 400 °F, depending on application).

PUMP
A rotary or reciprocating device using mechanical energy to propel liquids thru pipelines or to draw liquids from tanks or sumps by suction.

Q

QUARTER-TURN VALVE / ACTUATOR
A valve or actuator which has a maximum rotational travel of 90°, i.e., one quarter of 360°(Butterfly/Ball Valves).

R

RADIOGRAPHIC INSPECTION
A nondestructive inspection method using x-rays to locate internal flaws in castings, fabricated parts and welds. Abbreviated as RT.

RAISED FACED (RF)
The raised area of a flange face which is the gasket sealing surface between mating flanges. Defined in ASME B16.5. Class 150 and 300 valves have 0.06" RF and Classes 600 and up have a 0.25" RF.

REDUCED PORT – STANDARD PORT
A valve port opening that is smaller than the line size or the valve end connection size.

REGULAR PORT VALVE
A term usually applied to plug valves. The "regular" port of such a valve is customarily about 40% of the line pipe area.

REGULATOR
A throttling valve which exercises automatic control over some variable (usually pressure). Not an on-off valve.

RELIEF VALVE
A quick acting, spring loaded valve that opens (relieves) when the pressure exceeds the spring setting.

REMOTE CONTROL
The operation of a valve or other flow control device from a point at a distance from the device being controlled. Can be accomplished by electrical, pneumatic or hydraulic means.

RESILIENT SEAT
A valve seat containing a soft seal to assure tight shut-off.

REVERSE ACTING
Increasing input signal creates a decreasing output result (Ex. 4mA to close, 20mA to open).

RF (RAISED FACE)
The raised area of a flange face which affords a seal with a mating flange face by means of a flat gasket of the same diameter as the raised face. Used with a ring gasket.

RIM PULL
The force required at the edge of the handwheel to generate the required torque at the center of the handwheel.

RING TYPE JOINT (RTJ)
A flange connection using a specially shaped soft metal ring as a gasket. Generally used on high pressure valves. May be the body and bonnet connection and/or the end flange connection.

RISING STEM
A valve stem which rises as the valve is opened.

RS
Rising stem - A valve stem with threads arranged so that as the stem turns, the threads engage a stationary threaded area and lift the stem along with the closure element attached to it.

RTFE (Reinforced TFE, Filled Teflon and Glass Filled Teflon)
RTFE is compounded with a selected percentage of fiber glass filler to improve strength and resistance to abrasive wear, cold flow, and permeation in molded seats.

Reinforcement permits application at higher pressure and temperature than unfilled TFE. Typical temperature range is -40°F to 450°F. RTFE should not be used in applications that attack glass, such as hydrofluoric acid and caustics (sodium hydroxide).

RTJ
Ring Type Joint: A flange connection using a specially shaped soft metal ring as a gasket. Generally used on high pressure valves.

GLOSSARY/TERMS

RUPTURE DISC (BLOW-OUT DISC)
An emergency over-pressure relief device, employing a relatively thin diaphragm, designed to burst at a specified pressure. Cannot be reset - must be replaced after rupture event.

RUNNING TORQUE
The torque required to overcome resistance between the break torque and the end torque.

S

SAFETY RELIEF VALVE - SRV
A quick opening, pop action valve used for fast relief of excessive pressure.

SATURATED STEAM
Standard steam used in many industrial plants, factories, hospitals. Used for heating and as a utility. Contains some entrained water.

SCHEDULE
A system for indicating the wall thickness of pipe. The higher the schedule number, the thicker the wall for a certain pipe size.

SCOTCH YOKE OPERATOR
A quarter turn operator using a scotch yoke mechanism. The "Scotch Yoke" has a torque output at the beginning and ending of its stroke that is generally twice the magnitude of the torque output in the center of its stroke.

SCREWED ENDS
Internally threaded end connections supplied on some valves. Usually tapered pipe threads (NPT).

SEAL WELD
A weld that does not contribute anything to the mechanical integrity of an assembly, but is made purely to seal or prevent leakage from, for instance, a threaded joint.

SEAT
That part of a valve against which the closure element (gate, ball) effects a tight shut-off.

SEATING TORQUE
The torque required for the last few degrees of travel in bringing a valve fully closed.

SEGMENTED BALL
Greater efficiency and control characteristics are obtained by using a segment or a "slice" of a ball rather than the whole ball itself. This type of control valve is better at controlling than a V-port ball valve, but not quite as good as a globe style control valve.

SELF RELIEVING
The process whereby excessive internal body pressure, in some valves, is automatically relieved either into the upstream line by forcing the seats away from the closure element.

SET POINT
Input variable of a safety valve, reducing valve or controller that sets the desire value of the variable to be controlled.

SHUT- OFF PRESSURE
The maximum upstream pressure a valve will hold with zero leakage (bubble tight) downstream.

SHUT-OFF VALVE
A valve designed only for on/off service. Not a throttling valve. Sometimes referred to as a "block valve."

SIDE LOADING
This happens when the stem of the valve is pushed to one side by vibration, installation issues or other conditions. This causes premature wear of the stem packing and will cause leaks.

SIGNAL
The impulse given which is necessary to activate or control a positioner. These impulses are either pressure (3-15 PSI) or electrical (4-20 mA). As the signal increases or decreases, the positioner tells the actuator to change position.

SINGLE – ACTING
Refer to SPRING RETURN.

SLAB GATE
A gate having flat, finely finished, parallel faces - as opposed to a wedge gate. Such a closure element slides across the seats and does not depend on stem force to achieve tight shut off.

SLAVE LINKAGE
A push rod assembly which serves to connect the slave valve to the master valve in a three-way valve/actuator assembly.

SLAVE VALVE
The valve in a three-way valve/actuator assembly which is operated via a connection (slave linkage) to the master valve.

SLURRY SERVICE
An application involving a flow medium (like water) consisting of small solid particles suspended in a liquid.

SOCKET END
An end connection in which a pipe or tube is inserted into a counterbored hole and then brazed or fillet welded.

GLOSSARY/TERMS

SOCKET WELD END (SWE)
The end connection of a valve suitably prepared for socket welding to a connecting pipe.

SOLENOID VALVE
A device, typically electrically operated, that is used to switch a pneumatic signal between opening to closing of a pneumatic actuator.

SOUR GAS
Natural gas containing significant amounts of hydrogen sulfide (H2S). Requires special material treatments to avoid failures from sulfide corrosion cracking.

SOV – SOLENOID OPERATED VALVE
Solenoid Operated Valve - A generic term to identify a valve that is operated in a system using a solenoid valve.

SPECIFIC GRAVITY
The ratio of the weight of a given volume of fluid to the weight of an equal volume of water (if the fluid is a liquid) or to the weight of an equal volume of air (if the fluid is a gas).

SPEED CONTROL VALVE
A small metering fitting/valve which is a combination needle valve/ muffler. The idea is to meter the exhaust out of the actuator/solenoid only. (A common actuator, assembly uses two (2) speed control valves to control speed in both directions.

SPDT SWITCH
This is the Single Pole, Double Throw type electric switch. An SPDT switch routes one input circuit to one of two output circuits. This type of switch is sometimes called an A/B switch because it lets you choose between two circuits, called A and B. An SPDT switch has three terminals: one for the input and two for the A and B outputs. A type of limit switch.

SPLIT RANGING
In certain flow requirements, with large as well as small demands, as in seasonal heating situations, a single input, producing 2 or more control signals for 2 or more final control elements can be produced with or without overlap. Often used for high rangeability requirements. It requires 2 valves covering the total application with 1/3, 2/3 strategies.

SPOOL PIECE
A piece of piping that is used to fill in an area when using a smaller face to face valve.

SPRING RETURN (SR)
Pneumatic Actuator requires power to operate an actuator in a single direction. A mechanical spring will operate the actuator in the opposite direction when the power has been removed. (Fail Open or Fail Close) This type of actuator is normally used for applications where it is necessary for the valve to move to the open or close position upon loss of air supply, whether by design or by system failure.

SPRING RETURN (SS) SPRING START
At the beginning of the spring cycle the springs are fully compressed; the stored energy and torque output of the spring is at the maximum.

SPRING RETURN (SE) SPRING END
At the end of the spring cycle the springs are de-compressed and the torque output of the spring is at the minimum.

SPRING RETURN (AS) AIR START
At the beginning of the air cycle the springs are de-compressed and the air torque output is at the maximum.

SPRING RETURN (AE) AIR END
At the end of the air cycle the springs are fully compressed and the air torque output is at the minimum, due to increasing energy required to compress springs.

SPST - SINGLE-POLE, SINGLE THROW
This is the Single Pole, Single Throw type electric switch. A basic on/ off switch that turns a single circuit on or off. An SPST switch has two terminals: one for the input and one for the output. A type of limit switch.

SQUARE OPERATING NUT
A nut, usually 2” x 2”, which is attached to a valve stem or the pinion shaft of a gear operator allowing use of wrenches to quickly operate the valve. Commonly used in underground or buried services.

STAINLESS STEEL (SS)
Any of a number of types of iron alloy with chrome, nickel, or other elements that does not oxidize in free air.

S.T.A.M.P.E.D / STAMPED
Acronym for: SIZE - TEMPERATURE - APPLICATION - MATERIALS (OR MEDIA) - PRESSURE - END CONNECTIONS - DELIVERY To be used to collect the minimum of information from a customer.

STEM INDICATOR (VPI - VISIBLE

GLOSSARY/TERMS

POSITION INDICATOR)
A position indicating rod supplied with gate valves. It extends from the top of the valve stem and serves to indicate the relative position of the gate.

STEM NUT
A one or two-piece nut which engages the stem threads of a valve and transmits torque from an operator to the valve stem.

STEM
A rod or shaft used to transmit motion from an operator to the closure element of a valve.

STEM TORQUE
The force required at the valve stem to open or close the valve against system pressure and service conditions.

STREET ELL
A 90° pipe fitting with male thread and female threaded or socket weld ends.

STUD
A bolt, threaded on both ends, often used in bolting together two flange connections, using nuts.

STUFFING BOX
The annular chamber provided around a valve stem in a sealing system into which deformable packing is introduced. See “Packing”, “Gland”.

SUBMERSIBLE SERVICE
Underwater or subsea installation. Valves require special treatment to protect against corrosion and external seawater pressure. Also, special consideration needs to be taken in to account for all electrical components.

SUPERHEATED STEAM
Starts as saturated steam and is further heated. Removes all moisture and makes it 100% dry. A common application is in power plants to operate turbines.

SUPPLY PRESSURE
The plant air supply pressure available to operate a pneumatic actuator. (Instrument Air) .The pressure (pneumatic or hydraulic) applied as the power source to operate an actuator.

SWEET GAS
Natural gas having no significant hydrogen sulfide content.

SWING CHECK VALVE
A check valve in which the closure element is a hinged clapper which swings or rotates about a supporting shaft. See “Clapper”; “Check Valve”.

T

TEE
A pipe or tubing fitting with three outlets, two sides and one bottom connection. Resembles a “T”.

TEFLON®
DuPont trade name for fluorocarbon polymer. TFE, FEP, and PFA are fluorocarbon polymers.

THERMOSTAT
An automatic device for regulating temperature inside the enclosure of an electric actuator. Used in conjunction with a heater (anti-condensation).

THREE-WAY SOLENOID VALVE
A solenoid valve having three pipe connections and two orifices alternately supplying pressure and an exhaust port. These are commonly used with spring return actuators. Upon signal (electric current), supply pressure is allowed to pass through to one side of the actuator. When the signal (electric current) is removed, it exhausts pressure allowing the mechanical actuator spring to return to its original or relaxed condition.

THROTTLING
The intentional restriction of flow by partially closing or opening a valve. A wide range of throttling is accomplished automatically in regulators and control valves.

THROW
In reference to an electric switch, the term “throw” indicates the number of circuits the switch can control. The moving contact member of a single-throw switch completes only one circuit. A double- throw switch, however, permits its moving contact element to alternately complete two extreme positions and, hence, control two circuits.

THRU-CONDUIT
An expression characterizing valves when in the open position, wherein the bore presents a smooth uninterrupted interior surface across seat rings and thru the valve port, thus affording minimum pressure drop. There are no cavities or large gaps in the bore between seat rings and body closures or between seat rings and ball/gate. Consequently, there are no areas that can accumulate debris to impede pipeline cleaning equipment or restrict the valve’s motion.

GLOSSARY/TERMS

THRUST
The net force applied to a part in a particular direction - e.g., on the end of a valve stem.

TOP ENTRY
The design of a particular valve or regulator where the unit can be serviced or repaired by leaving its body in the line, and its internals can be accessed by removing a top portion of the unit.

TORQUE
The turning effort required to operate a valve. Usually expressed in “Inch Pounds or Foot Pounds”.

TORQUE SWITCH
An electrical device some electric actuators which cuts off power to the operator when allowable torque is exceeded, thus preventing damage to the valve and/or the operator.

TRANSDUCER
Converts one quantity of information to that of different information and quantity I/P, A/D. Examples above translate to: I/P is a current to pneumatic conversion, while A/D is analog to digital

TRANSFORMER
Transformers are simple voltage changers or converters. An example of their use is in converting a power source from 220 VAC to 120 VAC.

TRANSMISSION LINE
A main pipeline transporting oil or gas from wells or storage fields to refineries, loading docks or distribution companies. Generally, the pipeline is bigger than 6” and the pressure greater than 150 psi.

TRANSMITTER
A device that transmits a signal from the valve/actuator to a remote location. These units are generally electronic (Ex. 4-20mA and 0-1K Ohm). Can also be a standalone instrument that give a constant position feedback (Ex. Pressure transmitter).

TRAVEL STOPS
A mechanical means for adjusting the amount of travel of a valve/actuator. Typically, the amount of travel adjustment with the manufacturer’s standard stops is marginal.

TRIM
Commonly refers to the valve’s working parts and to their materials. Usually includes seats, seat ring sealing surfaces, balls, discs, wedges, plugs and stems.

TRIPLE OFFSET VALVE (BUTTERFLY VALVES)
A butterfly valve that has a carbon steel or stainless steel body with a stellite or metal seat. The design of the butterfly valve where the stem is located behind the disc, below the centerline of the disc, and its cone axis is offset from the centerline of the disc. This valve has much higher temperature ratings and has a zero leakage design. Commonly provided with double flanged ends, but lugged, wafer and a double flanged version with gate valve face to face are also available.

TRUNNION
That part of a ball valve which holds the ball on a fixed vertical axis and about which the ball turns. It is on the bottom of a trunnion ball valve and acts as a lower stem.

TURNS TO OPERATE
The number of complete revolutions of a handwheel or the pinion shaft of a gear operator required to stroke a valve from fully open to fully closed or vice versa.

TWO INCH SQUARE OPERATING NUT
A nut attached to the valve stem or to the pinion shaft of a gear operator. Valves so equipped are usually situated below grade in road boxes and are operated by long handled “T” wrenches.

U

UHMWPE – ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE
A material that can be used as ball valve seats, plug valve sleeves, or in lined valves. This can be used in abrasive applications. It also can be used in nuclear applications and the tobacco industry.

UL
Stands for Underwriters Laboratories Incorporated. It is an independent American testing and listing agency.

ULTRASONIC INSPECTION
An inspection procedure using high frequency sound waves to detect voids and imperfections throughout the thickness of metal parts.

UNION BONNET
A type of valve construction in which the bonnet is held on by a union nut with threads on the body.

GLOSSARY/TERMS

UNION CONNECTION
A small 3-piece fitting used to join two lengths of pipe. A female piece is installed on each of the two pipe ends and the connection is mechanically sealed by an external nut.

UNSEATING TORQUE
The torque required or the first few degrees of travel in opening of the valve.

URETHANE
A plastic type lining or seat that can be used in knife gate valves and butterfly valves. This is a very abrasion resistant material.

V

VACUUM
A space from which air or gas has been exhausted until its pressure is less than atmospheric pressure, i.e., any pressure below 14.7 psi absolute. A common unit of measurement is in-Hg (inches of mercury).

VALVE
A device used to control the flow of fluid contained in a pipe line using a variable orifice.

VELOCITY
The speed at which a fluid flows thru a line in a specified direction. Usually expressed in “feet per second.”

VENTURI VALVE
A reduced bore valve. A valve having a bore smaller in diameter than the inlet or outlet. For example, an 8”x 6” x 8” ball valve has 8” inlet and outlet connections while the ball and seats are 6”. The flow through a venture valve will be reduced because of the smaller port. Venturi valves can often be economically substituted for plug valves.

VISCOSITY
Can be considered as “fluid friction.” As viscosity or specific gravity increases, the internal friction resists flow. Consider two glasses, one with water and one with honey. Drop a rock into each from the same height and one will splash and one will not. It’s that simple.

VITON® (FLUOROCARBON, FKM, OR FPM)
Fluorocarbon elastomers are inherently compatible with a broad spectrum of chemicals. Because of this extensive chemical compatibility which spans considerable concentration and temperature ranges, fluorocarbon elastomers have gained wide acceptance as a material of construction for knife gate valve seats. Fluorocarbon can be used in most applications involving mineral acids, salt solutions, chlorinated hydrocarbons and petroleum oils. It is particularly good in hydrocarbon service. Temperature rating is from -20°F to +300°F. Color is brown, gray (black) or red and may be used on bleached paper lines. Fluorocarbon (VITON) is not suitable for steam or hot water service.

VOLTAGE
Electric potential or potential difference (120V, 240V, 440V, etc.) Expressed in volts.

W

WALL THICKNESS
The thickness of the wall of the pressure vessel or valve. For steel valves, minimum thickness requirements are defined in ASME B16.34, API 600, and API 602.

WATER HAMMER
The physical effect, often accompanied by loud banging, produced by pressure waves generated within the piping by rapid change of velocity in a liquid system Valves opening and closing quickly can cause this.

WE OR W.E. - WELD END
The end connection of a valve which is to be installed by welding into the line. To prepare the end bevel, it is necessary to know the wall thickness and specified minimum yield strength of the connecting pipe.

WEATHER PROOF
Describes a valve operator or other device that is protected against intrusion of water, sand, dust, or other atmospheric contamination. Can be associated with NEMA 4 electrical classification.

WEDGE GATE
A gate whose seating surfaces are inclined to the direction of closing thrust so that mechanical force on the stem produces tight contact with the inclined seat rings.

WELD NECK FLANGE
A flanged piping element with a weld neck used in pipeline construction to provide a companion flange for installation of flanged valves. Also used to convert weld end valves to flanged valves or vice versa.

WELD REDUCERS
A reducing fitting used on weld end piping components to adapt from a large sized pipe to a smaller diameter pipe, or vice versa. Types are Concentric and Eccentric.

GLOSSARY/TERMS

WETTED PARTS
The components of the valve that will see the media flowing through it. This includes the valve trim and, in some valve types, it can also include the valve body.

WIRE DRAWING
In cases with high velocity flow, which can be experienced in flowing conditions with the ball/disc/plug relatively close to the seating surface, the destructive “streaming” of liquid jets across the seating surface can erode or cut grooves in the surfaces. This resembles grooves produced as if wire was drawn across the surface at high speeds so as to cut into the material. This is but one reason to make sure valves are not oversized since control at low flow rates will demand a very close proximity of plug to seat, and wire drawing will result. No shutoff would be possible once this had begun to occur.

WOG - (WATER - OIL - GAS)
Used in connection with a pressure rating. This would be the maximum pressure that a valve could handle at ambient temperatures (not class rated). Thus: 100 WOG indicates the rated pressure is 100 psi in water, oil, or gas service, at normal ambient temperatures.

WORKING PRESSURE
The pressure (psi - pounds per square inch) at which a valve is designed to operate.

WORM GEARS
Gears used to transmit motion or power between right angle shafts when a high-ratio reduction is necessary. The worm is the small gear which drives the larger ring gear. Worm threads resemble screw threads and are available in various leads and pitches.

WP - WORKING PRESSURE
The pressure (pounds per square inch) at which a valve is designed to operate. Same as “operating pressure rating.”

WRENCH OPERATED
The operation of a valve by means of a handle or lever. Used on smaller size and lower pressure class valves.

Y

YOKE
Part of a gate valve that serves as a spacer between the bonnet and the operator actuator.

RESOURCES

FERGUSON INDUSTRIAL
fergusonindustrial.com

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)
asme.org

NACE (NATIONAL ASSOCIATION OF CORROSION ENGINEERS)
nace.com

API (AMERICAN PETROLEUM INSTITUTE)
api.com

ANSI (AMERICAN NATIONAL STANDARDS INSTITUTE)
ansi.org

ISA (INTERNATIONAL SOCIETY OF AUTOMATION)
isa.org

VMA (VALVE MANUFACTURERS ASSOCIATION)
vma.org

PED (PRESSURE EQUIPMENT DIRECTIVE)
ec.europa.eu/.../pressure-equipment/directive_en

Thank you to our manufacturers and professional organizations for your contributions and expertise to the Blue Book.

FERGUSON INDUSTRIAL QUALITY PROGRAM

Peace of Mind: Delivering the Highest Value to Our Customers

QUALITY PEOPLE

We are focused on building strong relationships and understanding the complexities that challenge our customers. Our knowledgeable and experienced Team delivers superior customer service with a consistent and reliable expertise our customers depend on.

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ISO/IEC 17025: Our Metrology and Material Services (MMS) testing laboratory is accredited to the ISO/IEC 17025 standard. This accreditation certifies our laboratory's ability to produce accurate and impartial testing data when inspecting and evaluating products.

For a full list of certified locations, contact a Ferguson Industrial associate or email iso.quality@ferguson.com.

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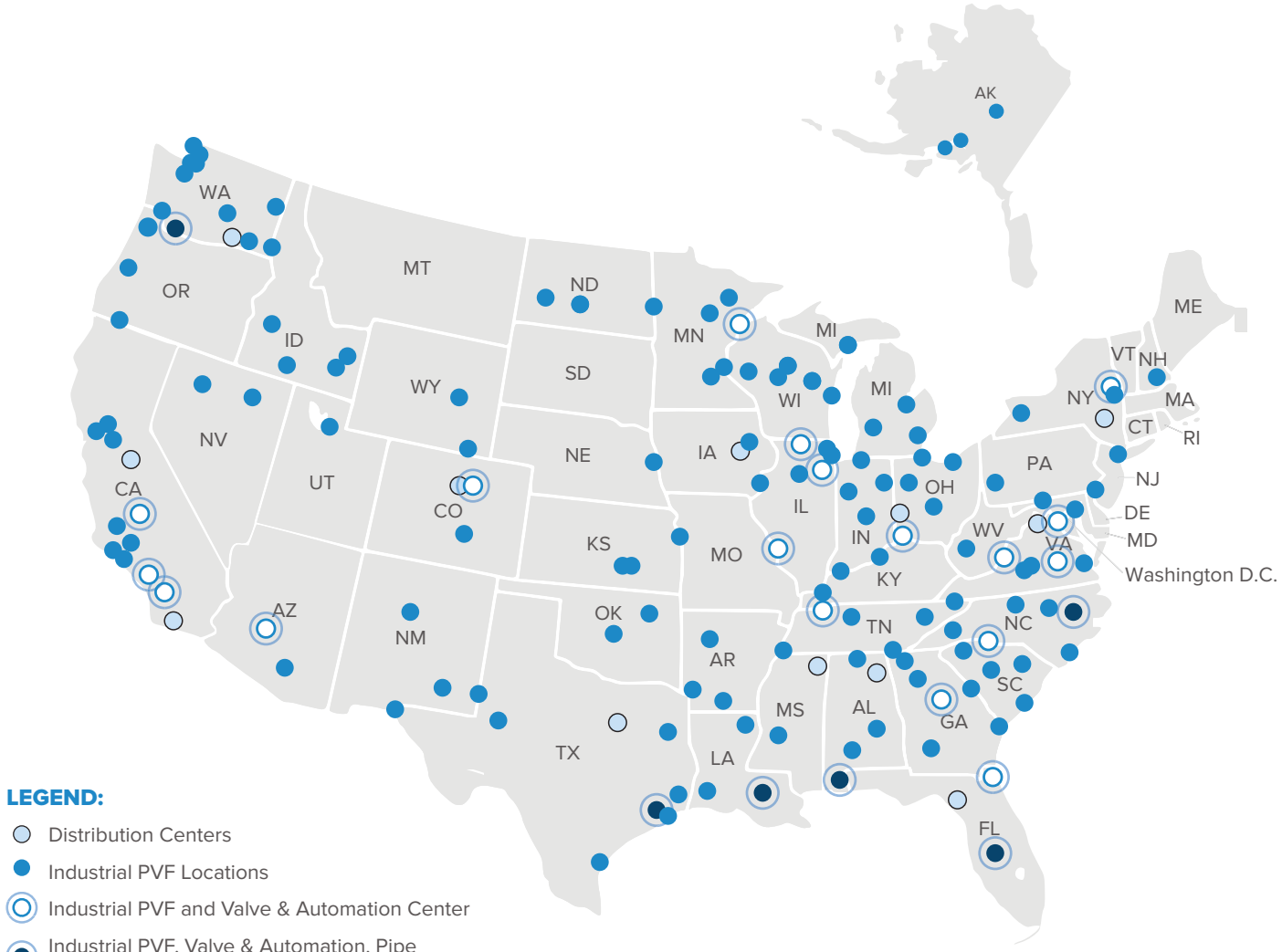

LEGEND:

- Distribution Centers
- Industrial PVF Locations
- Industrial PVF and Valve & Automation Center
- Industrial PVF, Valve & Automation, Pipe Fabrication (HDPE, Lined Pipe, Gaskets)*

*Capabilities may vary by location

FERGUSON INDUSTRIAL