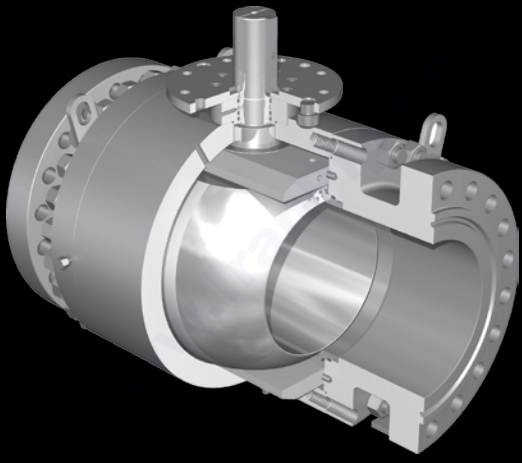
CAMERON

Glossary of Valve Terms



Glossary of Valve Terms

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Section 1: Valve Terminology

AGA – American Gas Association

A society comprising gas companies set up to achieve common goals.

AISI – American Iron and Steel Institute

An association of steelmakers that sets standards for the chemical and physical properties of steel and iron in various shapes and forms – pipe, tubing, sheet, strip, and wire.

ANSI – American National Standard Institute

The principle organization in the US that oversees the creation, promulgation and use of 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 US oil company trade association. It has some standards and specification writing functions, such as wellhead components and pipeline valves.

API SPEC 6FA

The API specification dealing with the fire testing of pipeline valves. Once a particular size and pressure class valve is tested and passes the API fire test, all such valves can be identified with the above monogram. API-6FA supersedes API-RP-6F.

API SPEC 6D

An API specification dealing with pipeline valves. Most pipeline valves are manufactured to this specification and, if so, can be identified with the API 6D monogram.

ASME – American Society of Mechanical Engineers

This professional society publishes technical books, papers, codes, and standards. Of principal interest is the ASME Boiler and Pressure Vessel Code which is referenced for many aspects of valve making.

ASTM – American Society for Testing and Materials

A professional society governing the 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.

AWS – American Welding Society

A society which sets guidelines and standards for all welds.

Accumulator

A vessel in which a gas is trapped and compressed by the liquid in a hydraulic system, thus storing energy to supply liquid under pressure to the system when needed.

ACME Thread

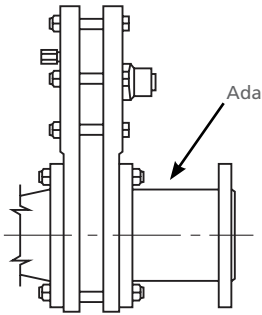
A flat-topped screw thread for power transmission. This thread has a 29-degree included angle between adjacent thread faces compared with the 60-degree angle of the US standard V thread.

Actuator

See "Operator".

Adapter Spool

An extension that is added to a short face-to-face valve to conform to standard API 6D face-to-face dimensions.



SHORT PATTERN GATE VALVE
WITH ADAPTER SPOOL

All-Welded Construction

Pertains to a valve construction in which the body is completely welded and cannot be disassembled and repaired in the field.

All-Welded Construction
(No Bolted Body Parts)

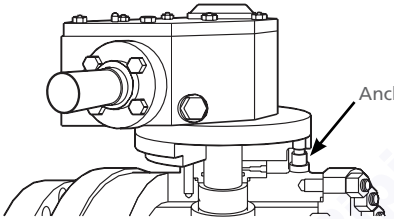
CAMERON® FULLY WELDED BALL VALVE

Ambient Temperature

The prevailing temperature of the environment immediately surrounding an object.

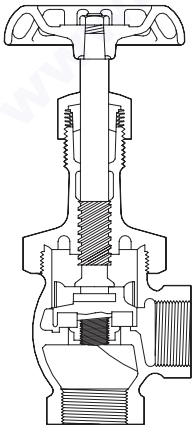
Anchor Pin

A pin welded to the body of a ball valve. This pin aligns the adapter plate and keeps the plate and gear operator from moving while the valve is being operated.



Angle Valve

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



ANGLE VALVE

Atmospheric Pressure

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

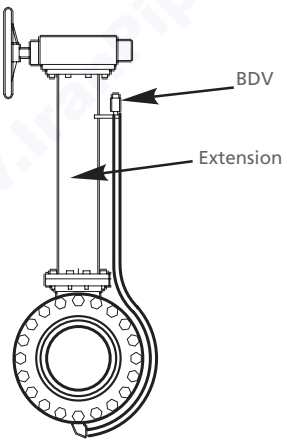
BBL (bbl)

An abbreviation for "barrel". Used to express liquid volume. One barrel of oil is equal to 42 US gallons.

BDV – Blowdown Valve

A BDV is a valve or system of valves that, when activated, initiates a blowdown of a pipeline, plant, process, or platform; similar to an ESDV that shuts in a pipeline, the BDV opens a pipeline.

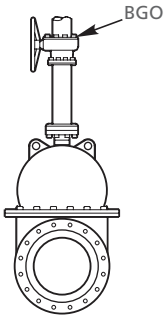
See "Block-and-Bleed", "Extended BDV".

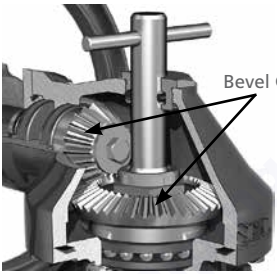


BALL VALVE WITH DRAIN LINE EXTENSION

BGO – Bevel Gear Operated (or Operator)

The actuation of a valve 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. The reduction ratio of this gear set determines the multiplication of torque achieved. Used on gate valves.

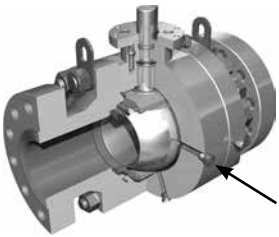




GATE VALVE WITH BGO

BRV – Body Relief Valve

A relief valve (optional) installed on ball valves used in liquid service to provide for the relief of excess body pressure caused by thermal expansion.



BS 6755

The British Standard specification dealing with the fire testing of pipeline valves. Once a particular size and pressure class valve is tested and passes the BS 6755 fire test, all such valves can be identified with the BS 6755 standard.

BVR – Ball Valve Regulator

An automatic throttling valve controlling flow or pressure in a pipeline comprising a package involving a ball valve, actuator, positioner, and controlling instrument.

Backpressure Regulator

Regulator designed to control upstream pressure.
See "Regulator".

Back Seat

A shoulder on the stem of a valve that seals against a mating surface inside the bonnet.

Ball

The spherical closure element of the ball valve.

Ball Valve

A valve using a spherical closure element (ball) which is rotated through 90 degrees to open and close the valve.

GROVE® B5 BALL VALVE

Bar

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

Belleville Spring

A spring resembling a dished washer, used in some ball valves to push the seats against the ball. They also are used to provide live-load to packing systems on globe and wedge gate valves.

Bending Moment

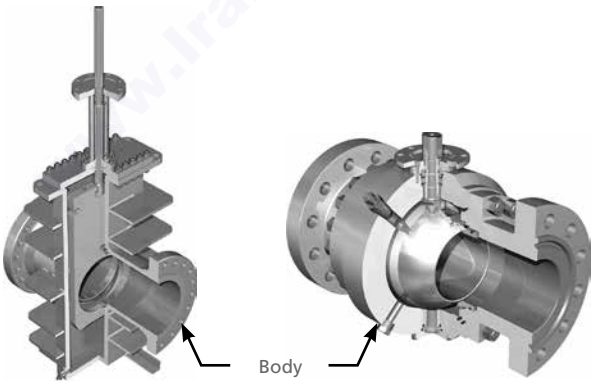
The mechanical bending load produced by a force applied to a part at a right angle to its surface or axis. The product of the force times the perpendicular distance to the point of restraint. Usually expressed in pound-feet.

Bevel

A chamfer. The angle between two adjacent surfaces (other than 90 degrees). The word "bevel" is used in describing weld-end preparations. *See "End Bevel".*

Block-and-Bleed

The capability of obtaining a seal across the upstream and downstream seat rings of a valve when the body pressure is bled off to the atmosphere through blow down valves or vent plugs. Useful in testing the integrity of seat seals and performing minor repairs under pressure.



GROVE® G4N GATE VALVE GROVE® B4 BALL VALVE

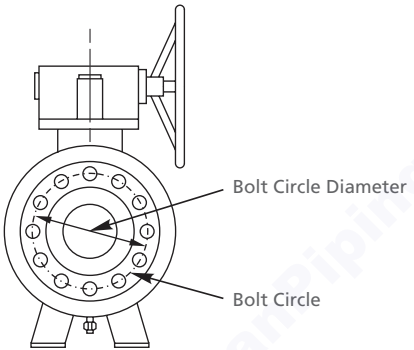
(Other examples include GROVE® B5, B7, B8, BT, and CAMERON® T30 ball valve)

Bolt

A fastener that normally has a square or hex head and is threaded on the opposite end to receive a nut. Sometimes used to make up a flanged connection.

Bolt Circle

The circle on which bolt holes are located.

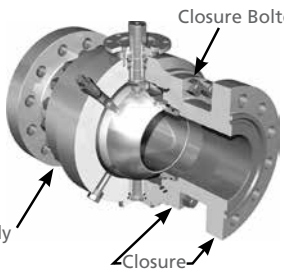


Bolted Bonnet

A bonnet that is connected to a valve body with bolts.

Bolted Construction

Describes a valve construction in which the pressure shell elements are bolted together, and thus can be taken apart and repaired in the field.



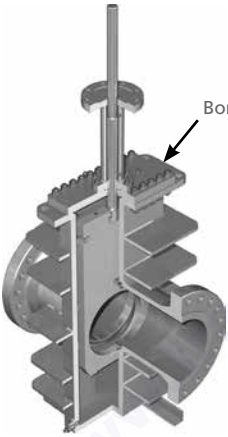
GROVE® B4 BALL VALVE

Bolting Sets

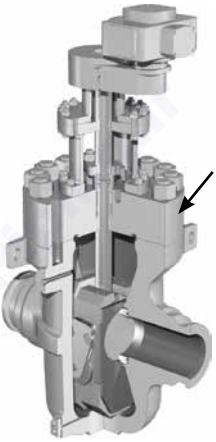
Bolts or studs and nuts sometimes supplied with flanged valves to install the valve between line flanges.

Bonnet

The top part of a valve, attached to the body, that guides the stem and adapts to extensions or operators.



GROVE® G4N
GATE VALVE



RING-O® DOUBLE
EXPANDING GATE VALVE

Bore (or Port)

The inside diameter of the smallest opening through a valve. The diameter of the hole in the ball of a ball valve. The diameter of the hole in the gate of a gate valve. The inside diameter of seat rings.

Brinell Hardness Number

A number indicating metal hardness using the Brinell scale. Can be converted to Rockwell B and C hardness by reference to conversion tables.
See "Rockwell Hardness No".

Bubble-Tight Shutoff

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 through water. To qualify as bubble-tight, no bubbles should be observed in a prescribed time span.

Buried Service

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

Burst Pressure

The pressure (psi) at which rupture of a stressed element or pressure-containing vessel takes place.
See "Ultimate Strength".

Butt-Weld Ends

The end connections of a valve, suitably prepared for butt welding to connecting piping.
See "WE", "End Bevel".

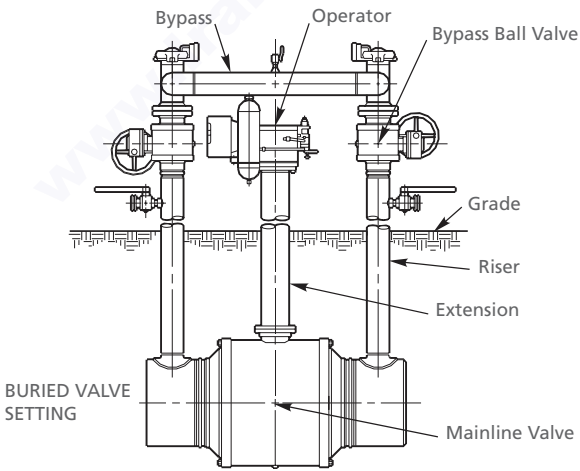
Butterfly Valve

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

WKM® DYNACENTRIC™
HIGH-PERFORMANCE
BUTTERFLY VALVE

Bypass

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



C-Pack

A special stem packing designed by GROVE® to give maximum lifetime sealing in gate and check valve stems.

C.I.F. – Cost Insurance and Freight

Shipper pays all freight and insurance charges. Same as FOB destination.

C_v

The capacity factor of a valve, also called the valve coefficient; specifically, the number of gallons of water per minute that will flow through a valve with a pressure drop of 1 psi.

CWP – Cold Working Pressure

See "MWP".

Capacity Factor

See "C".

Capscrew

A fastener with a head whose shank is normally threaded throughout its entire length. It is not used with a nut, but rather engagement is made with a female thread in the piece to be joined.

Cast

The form of a particular part of a valve, where the basic shape is formed by molding rather than fabricating.

Casting

A part that has been formed by pouring molten metal into a mold.

Cavitation

The rapid formation and collapse of vapor pockets in a flowing liquid in localized regions of very low pressure – often a cause of erosive damage to pumps, throttling type valves and the piping itself. Can be the cause of excessive noise.

Certifying (or Certification) Authority (CA)

An independent body appointed by the purchaser to carry out a survey of the equipment and/or materials that they are buying. It is the responsibility of the supplier to provide the CA with information, documents, access to works and personnel to enable the survey to be carried out.

Chainwheel-Operated Valve

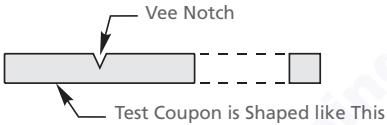
An overhead valve operated by a chain drive wheel instead of a handwheel.

Characterized Gate or Ball

A ball or gate, the shape of whose port has been specially altered to provide a specific throttling capability.

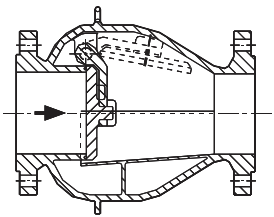
Charpy Test

A mechanical test conducted on a precisely machined coupon of the steel to be tested. The coupon is clamped in a special machine and subjected to a lateral hammer blow. This test provides a relative measure of the toughness of the steel or its resistance to shock or impact loads. Often required for low temperature applications where testing is done at the expected minimum service temperature. (Refer to requirements of API 6D and ISO 14313.)



Check Valve

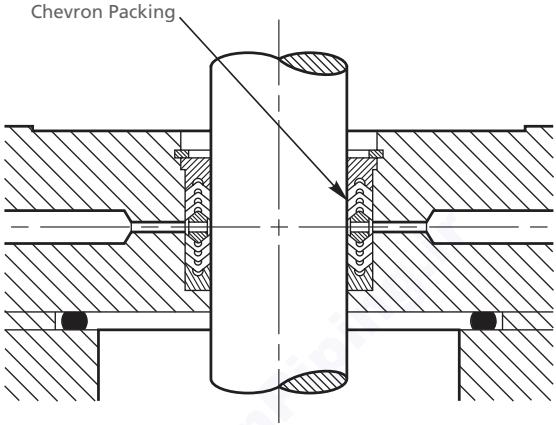
A one-directional valve that is opened by the fluid flow in one direction and which closes automatically when the flow stops or reverses direction. *See "Clapper".*



TOM WHEATLEY® SWING CHECK VALVE

Chevron Packing

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



City Gate (or City Gate Station)

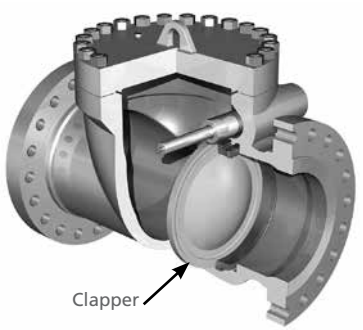
The metering and pressure-reducing station where gas is transferred from a high pressure cross-country transmission line to a low pressure distribution piping system within a city.

Cladding

A method of coating metals by which the coating becomes an integral part of the material. This normally is done by welding. It is generally done on valves where special trims are required for difficult applications.

Clapper

The hinged closure element of a swing-disc check valve.



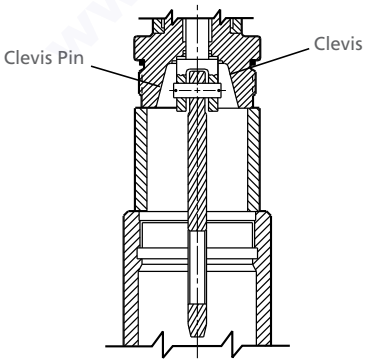
TOM WHEATLEY® SWING CHECK VALVE

Class

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

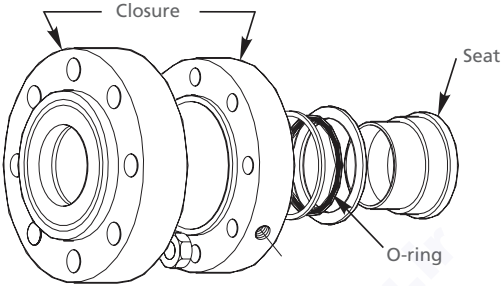
Clevis

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.



Closure

The end of a ball valve bolted to the body, which often contains the seat rings. Often referred to as part of the body.



Closure Elements (Obturator)

The moving part of a valve, positioned in the flow stream, which controls flow through the valve. Ball, gate, plug, clapper, disc, etc., are specific names for closure elements.

Coal Gasification

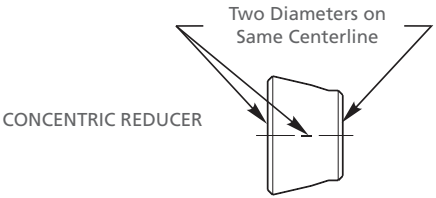
The process of manufacturing natural gas from coal.

Compressor

A device that converts mechanical energy into gas pressure.

Concentric

Having the same centers.

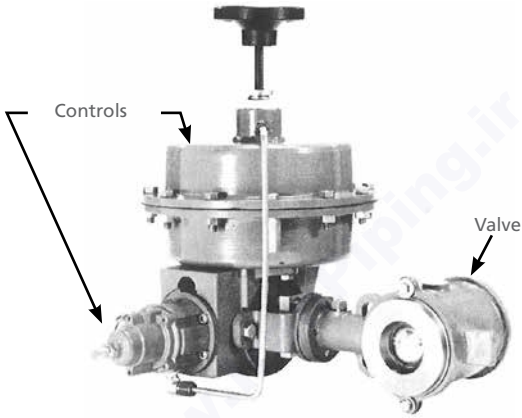


Contaminant

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

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. *See "Controller".*



CONTROL VALVE

Controller

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

Corrosion

The deterioration of a material due to chemical action.

Corrosion Allowance – CA

An additional amount of wall thickness that is added by calculation to account for planned corrosion over the lifetime of a pressure vessel.

Coulisse

Of or using runners or slides as a guiding mechanism, as in a Coulisse-style gate valve.

Crude Oil

Unrefined oil. Oil as it comes directly from the well.

Cryogenic Temperature

Any temperature below about -240° F (-151° C).

Cryogenic Valve

A valve capable of functioning at cryogenic temperatures.

Cycle

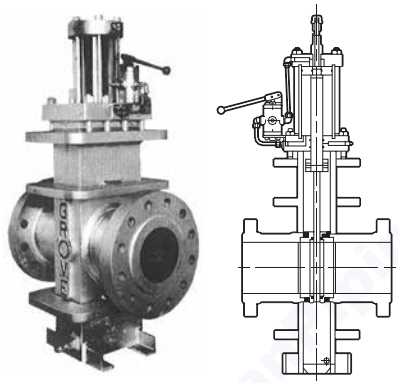
A single complete operation or process returning to the starting point. A valve, stroked from full open to full closed and back to full open, has undergone one cycle.

Cycle Test

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

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.
See "Power Operator".



POWER-PISTON VALVE

DPDT – Double-Pole Double-Throw

Related to electrical switches. *See "SPDT".*

DPST – Double-Pole Single-Throw

Related to electrical switches. *See "SPST".*

Delta (lP)

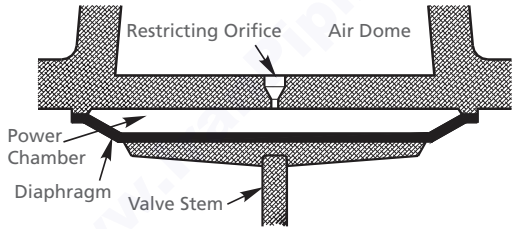
See "Differential Pressure", "Pressure Drop".

Design Appraisal

A procedure by which a certifying authority, appointed by the purchaser, appraises the design parameters of the equipment and/or materials they are buying. The supplier shall submit drawings, calculations, and documents as required to the CA, in conjunction with those normally required for review and acceptance by the purchaser.

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.



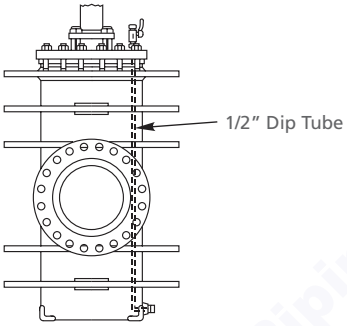
AIR-DOME REGULATOR DIAPHRAGM

Differential Pressure

The difference in pressure across a valve in a pressurized line. The difference in pressure between any two points in a pressurized system under flowing conditions.

Dip Tube

Extending the blowdown valve on large gate valves requires a tube that is located inside of the valve. This tube is called the "dip tube" and extends through the bonnet to the bottom of the body cavity.



Disc

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

Distribution Line

Pipeline which distributes gas to the service lines of individual consumers. Usually it is small in diameter (6" and under) and low pressure (under 150 psi).

Dot Regulations – Department of Transportation

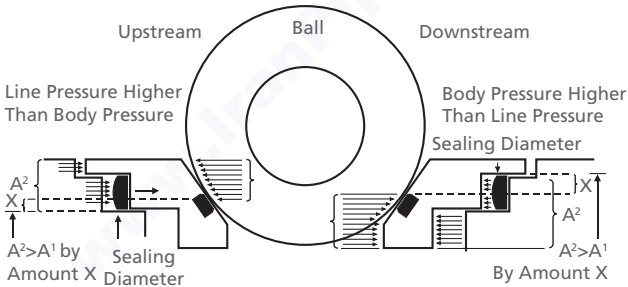
A code of federal regulations setting forth minimum safety requirements for the transportation of hazardous gases or liquids by pipeline.

Double Block-and-Bleed

A valving arrangement that ensures no flow in a line, even though the valve may leak. It consists of two block valves in the main line with a small bleeder valve draining the line between the block valves. *See "Block-and-Bleed".*

Double Piston Effect (DPE) Principle

The sealing principle of GROVE® ball valves whereby line pressure is used on both upstream and downstream floating seats to effect a dead-tight seal simultaneously on both sides of the ball. With the DPE seat configuration, when the upstream seat leaks, the pressure entering into the body cavity acts on the downstream seat, which, being of the DPE design, is then pushed against the ball, and the valve seals in both directions.



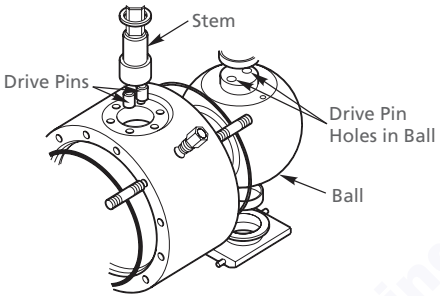
DOUBLE PISTON EFFECT PRINCIPLE

Drain Plug

A fitting at the bottom of a valve, the removal of which permits draining and flushing of the body cavity. The vent plug assembly on some ball and gate valves also serves as a drain valve. *See "Vent Plug".*

Drive Pins

The pins that fit into the bottom of a ball valve stem and engage corresponding holes in the ball. As the operator turns the stem, the drive pins turn the ball.



Droop

A drop in set (outlet) pressure of a regulator or control valve due to the travel of its valve or poppet as the required flow increases from low to maximum. A slight change in the control spring length due to the valve travel will result in spring force variations, translating into a change of set (outlet) pressure.

Dry Lube

Dry-film molydisulfide applied as a coating to sliding or rotating parts to reduce frictional drag. After application, the film is baked in an oven at high temperature.

"DU" Bearing

A bearing consisting of bronze impregnated with Teflon® (TFE) resin which is lead powder-bonded to a low-carbon steel backing.

Durometer

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

Dye Penetrant Inspection

See "Liquid Penetrant Inspection".

EMO – Electric Motor Operated

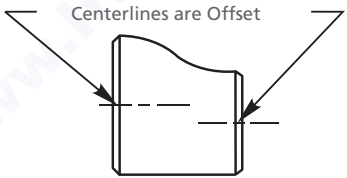
The actuation of a valve by electric motor.
See "Power Operator".

ESDV – Emergency Shutdown Valve

A valve or a system of valves that, when activated, initiate a shutdown of the plant, process, or platform they are tied to.

Eccentric

Not having the same center.



ECCENTRIC REDUCER

Elastomer

A natural or synthetic material. Used in synthetic rubber parts such as O-rings.

Elbow

A fitting used for changing direction in a run of pipe or tubing. *See "Ell", "Street Ell".*

90-DEGREE ELBOW

45-DEGREE ELBOW

Electroless Nickel Plating

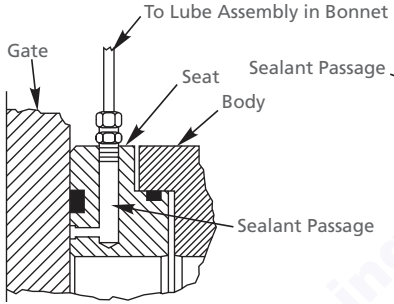
A plating process that requires no external electrical power and is the result of a chemical reaction between the part and the plating solution. A uniform consistent deposit and plating rate can be produced by controlling and adjusting the chemistry of the plating bath.

Ell

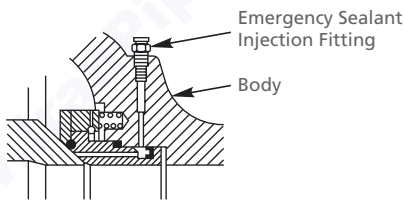
A pipe or tubing fitting that has the shape of an L. *See "Elbow".*

Emergency Seat Seal

To obtain tight shutoff in an emergency situation, a sealant can be injected into a specially designed groove in the seat rings. Available for most ball valves and gate valves.

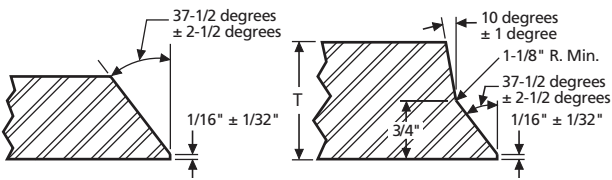


GATE VALVE



End Bevel

Weld end preparations for butt welding. Governed by ASME B31.4 and B16.25.



WELD END BEVELS

End Connection

The type of connection supplied on the end of a valve that allows it to be installed in a pipeline. Weld end, flanged end, screwed end.

Erosion

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

Expanding Gate Valve

A gate valve 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 seats. 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.

Explosion Proof

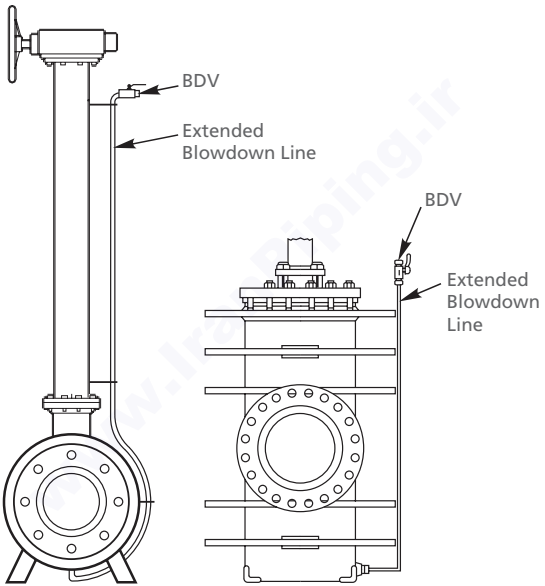
A statement associated with a design that is capable of passing certain specified tests after exposure to a potentially explosive environment. Generally, these tests must be referenced to a particular specification. This is especially important for electrical devices, such as solenoids and switches.

Export Packing

Special packing and crating that is required for export shipping. Includes sealing against a salt atmosphere (sea air).

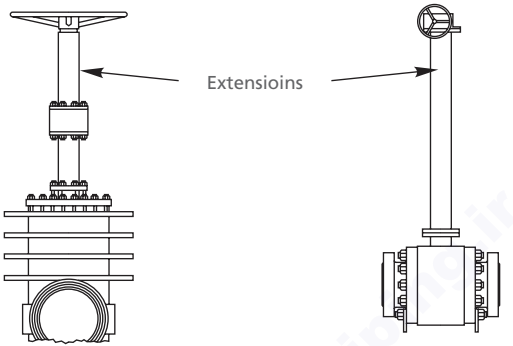
Extended BDV – Blowdown Valve

Used on buried valves where the drain plug is inaccessible. Instead, a line is piped above grade, terminating in a small valve. Line pressure is used to blow out condensates and other material which settles out in the bottom of the body cavity. *See "BDV".*



Extension Stem

The equipment applied to buried valves to provide above-grade accessibility to operating gear, blowdown, and seat sealant systems.



GATE VALVE BALL VALVE

External Coating

Coating applied to protect valves against various environments – sea air, salt water, earth burial, and normal air exposure.

FAS – Free Alongside

Term used for ocean shipment. Vendor pays transportation only to shipping dock alongside vessel.

FE – Flanged End

See "RF", "RTJ".

FEA – Finite Element Analysis

Computerized method of analyzing complex shapes by organizing the shapes into a series of smaller elements that

can be more accurately analyzed to determine whether or not components are suitable for their intended purpose.

FERC – Federal Energy Regulatory Commission

US government agency that has the final approval of new pipelines, right of ways, etc.

FOB – Free Onboard

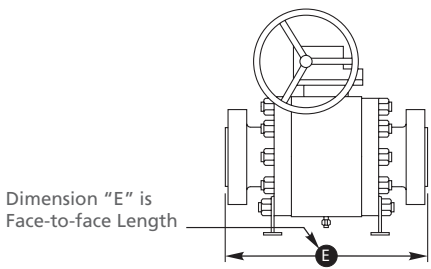
Transportation charges are absorbed by vendor to the FOB point. Usually a shipment is FOB Factory, in which case, title, and transportation charges pass to the customer when it leaves the factory.

Fabricated Valve

One in which the body and hub parts are not cast, but rather are formed from plate or pipe and then welded or bolted together.

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 interchangeable, regardless of the manufacturer.



Facing

The finish of the contact surface of flanged fittings.

Fail-Safe Valve

A valve designed to operate to a preferred position (open or closed) in order to avoid an undesirable consequence in a piping system. Refer to ESDV and BDV.

Fatigue Assessment

Fatigue resistance verification of a component subjected to a number of operating cycles.

Female Thread

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

Field Serviceable

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

Fire Gate

A gate or ball valve that is positioned in a pipeline at the entrance to a compressor station. This valve is closed in case of fire in the compressor station. Closing the valve prevents the gas in the pipeline from feeding the fire.

Fire-Safe

A statement associated with a valve design that 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 device used for connecting elements in fluid lines, e.g., elbows, tees, nipples, unions, flanges, etc.

Flange

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

Floating Ball

A ball valve having a non-trunnion mounted ball. The ball is free to float between the seat rings and has higher torque when compared to a similar size trunnion mounted valve.

Flow

A fluid in motion in a conducting line.

Flow Coefficient

The number of gallons of water per minute that will flow through a valve with a pressure drop of 1 psi. Also referred to as the C_v of the valve.

Flow, Laminar

The flow of a viscous fluid in which the fluid moves in parallel layers with a fixed velocity gradient from the centerline to the containing walls of the conduit. Sometimes referred to as "streamline" flow.

Flow Meter

An instrument used to measure flow rate or total flow or both.

Flow Rate

The volume or weight of a fluid passing through a pipeline or conductor per unit of time, e.g., 3000 b/d of oil; 4 MMcf/hr of gas.

Flow, Turbulent

The random flow of a fluid in which the velocity at a certain point in the fluid varies irregularly.

Fluid

Any non-solid substance that can be made to flow. Both liquids and gases are fluids.

Force

The intensity of an influence tending to produce motion, distortions, or change of shape. The product of unit force (psi) and the area over which it acts. Usually expressed in pounds.

Forging

A part that is formed by heating followed by hammering, rolling, or applying other compressive forces to create a specific shape.

Friction

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

Full Bore

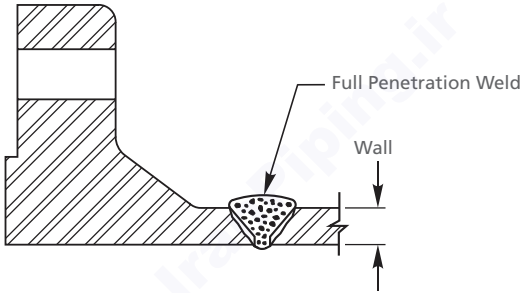
See "Full Opening".

Full Opening

Describes a valve whose bore (port) is nominally equal to the bore of the connecting pipe. *See "Venturi Valve".*

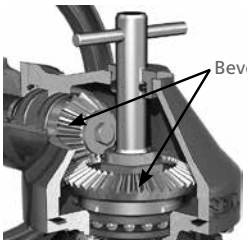
Full-Penetration Weld

Describes the type of weld wherein the weld metal extends across the entire wall thickness of the joint.

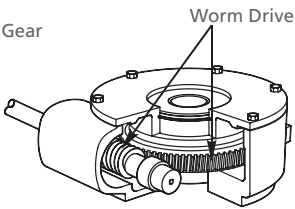


GO - Gear Operated

The actuation of a valve through a gear set which multiplies the torque applied to the valve stem. *See "BGO – Bevel Gear Operator", "MGO – Manual Gear Operator*".



BEVEL GEAR OPERATOR



WORM GEAR OPERATOR

Galling

The tearing of metal when two elements rub against each other. Usually caused by lack of lubrication or extreme contact pressure.

Gas

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

Gasket

A seal or packing placed between mechanical joints (such as flanges) to prevent the escape of the flowing medium.

Gate

The closure element of a gate valve.

Gate Valve

A straight-through 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.

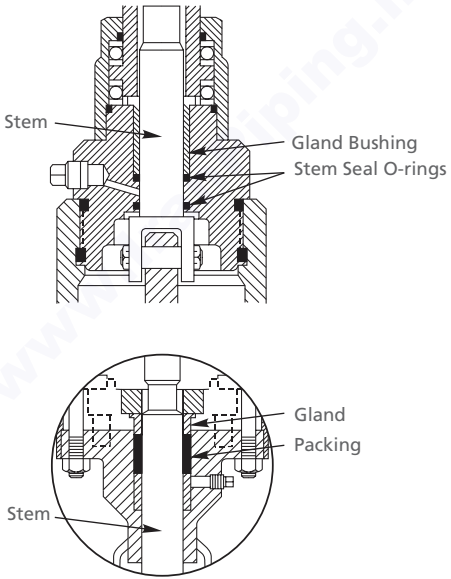
GROVE® G4 GATE VALVE

Gauge, Pressure

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.

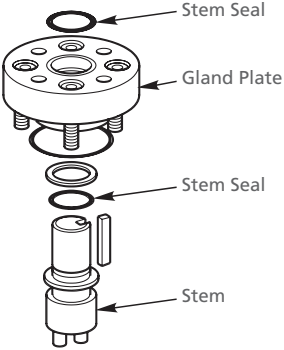
Gland (or Gland Bushing)

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 that 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 usually is parallel to the flow axis. The tortuous flow path produces a relatively high pressure loss.

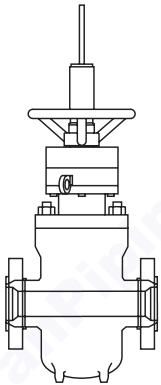
NAVCO® GLOBE VALVE

Grease Fitting

A fitting through which lubricant or sealant is injected.

HWO – Handwheel Operated

A valve on which the handwheel drives the stem directly to operate the valve.



Hard Facing

A surface preparation, such as detonation gun or high-velocity oxygen flow (HVOF), in which an alloy is deposited on a metal surface, usually by weld overlay, to increase abrasion and/or corrosion resistance.

Head

The height of an open column of liquid above a given datum, expressed in linear units; e.g., feet of water, inches of mercury, etc. It is another way of expressing pressure.

Header

See "Manifold".

Heat Analysis

A chemical analysis, conducted by the foundry immediately prior to pouring, which measures the exact chemical composition of a particular batch of molten metal. Does not include analysis of physical properties. *See "Mill Test".*

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.

Heat Treatment Charts

Furnace charts providing a temperature versus time record of the heating and cooling cycle, required by a specific heat treatment process for a particular furnace load of steel or steel parts.

Holiday

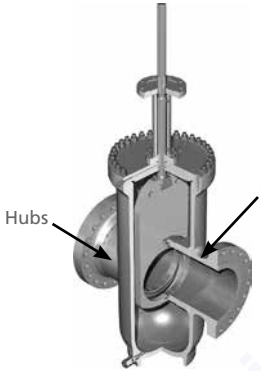
An imperfection or bare spot in a coating or plating.

Hot Tapping

The process by which a pipeline, under pressure, is cut into to provide a side outlet. A flanged fitting is saddle-welded to the pipeline and a full port valve bolted to the flange. The hot tapping machine, bolted to the outboard valve flange, is operated through the open valve. After cutting out a circular piece from the pipe wall, the tapping machine is removed and the valve closed.

Hubs

The end connection tubes on a gate valve.



GROVE® GATE VALVE

Hydraulic

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

Hydraulic Motor Actuator (or Operator)

A device by which rotation of an hydraulically powered motor is converted into mechanical motion.

Hydraulic Seats

The movement of the seats in a valve that are controlled by using water, oil, or other liquids under pressure.

Hydrostatic Test (or Shell Test)

A test in which a valve is completely filled with water and pressure tested. Used for conducting proof pressure testing. *See "Proof Pressure".*

ID – Inside Diameter

The measurement of the inner diameter of a circular part.

IDS – Instrument Data Sheet

A table summarizing data such as service, valve size, supply pressure, etc., necessary in prescribed pressure steps.

ISO – International Standards Organization

An organization that sets minimum international standards for a wide variety of items manufactured and used in pipeline services.

ISO 14313

The ISO specification for pipeline valves.

Incremental Seat Test

The leakage testing of valve seats in an assembled valve by increasing the applied pressure in prescribed pressure steps.

Inertia

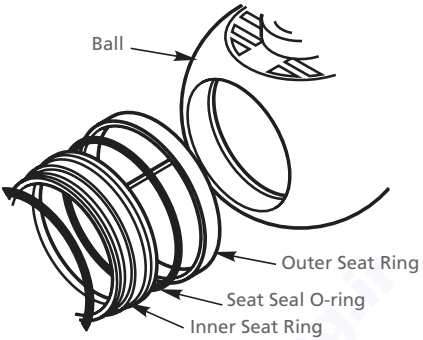
The property of a body or mass which resists a change in velocity.

Inlet Port

That end of a valve which is connected to the upstream pressure zone of a fluid system.

Inner Seat Ring

The inner part of a two-piece valve seat assembly.



Inside-Out Air Seat Test

A pressure test that can be performed only on a trunnion mounted ball valve with DPE seats. By closing the valves and pressurizing the body cavity, all of the seals in an independent seating ball valve can then be pressure tested.

In Situ Maintenance

To maintain or repair a product in its original place, such as a top entry ball valve or regulator.

Internal Pressure Relief

A self-relieving feature in non-DPE seating valves that automatically relieves excessive internal body pressure caused by sudden changes in line pressures. By means of the piston effect principle the excessive body pressure will move the seat away from its seating surface and relieve it to the lower pressure side.

Key Stop

A method of restricting the travel of a ball valve from fully open to fully closed. The stem key bears against the ends of an arc machined in the adapter plate.

LNG – Liquefied Natural Gas

Natural gas in the liquid state. For the gas 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 ashore in insulated tanks to await regasification.

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.

Lantern Ring

See "Chevron Packing".

Lifting Lugs

Lugs provided on larger ball, gate, and check valves, for lifting and positioning valves. Also called lifting eyes.

GROVE® BALL VALVE

Limit Switch

An electrical device providing a signal to a control system to prevent the travel of the valve past a predetermined point. Usually a component of a valve operator.

Line

A pipe, tube, or hose for conducting fluids.

Lip Seal

A circular seal ring of U-shaped cross section encompassing an elastomeric O-ring which provides resiliency and ensures a seal at the inner and outer lips of the U.

Liquid Penetrant Inspection

An NDE method of detecting the presence of surface cracks and surface imperfections in welds or castings through use of a special red dye.

Lock-Up Pressure

The differential pressure required to produce tight shutoff in a regulator. It is usually a few psi.

Locking Device

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

Lube Seats

Seats that are equipped with a lubricant injecting system. *See "Emergency Seat Seal".*

MAOP – Maximum Allowable Operating Pressure.

Determined in accordance with piping codes, DOT regulations, etc.

MDS – Material Data Sheets

The material data sheets define 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.

MGO – Manual Gear Operator

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

MMCF

An abbreviation for "million cubic feet" used to designate gas volume and gas flow rates in pipelines (MMcf/d or MMcf/hr).

MO – Motor Operated

See "Power Operator", "EMO".

MANUAL GEAR OPERATOR MOUNTED ON BALL VALVE

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 fitting industry. Recommendations of this society are advisory only.

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 pressure for various pressure classes are defined by ASME B16.34 or API 6A.

Magnetic Particle Inspection

An inspection procedure for detecting surface cracks in welded areas through the use of fine iron particles in an electrical field.

Male Thread

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

Manifold (or Header)

A common pipe or chamber having several lateral outlets.

MANIFOLD

Mass Spectrometer

An instrument used for sorting streams of electrified particles in accordance with their different masses by means of deflecting fields. The instrument can produce a photographic or graphic record of each compound and the percentage of the compound. Most commonly used in analyzing petroleum and steel products.

Mechanical Seal

In a valve, a shutoff that is accomplished by a mechanical means rather than with fluid or line pressure. The wedging action of a gate against the seats or the seat springs pushing the seat against the ball or gate are examples of mechanical seals in a valve.

Metal-to-Metal Seal

The seal produced by metal-to-metal contact between the sealing face of the seat ring and the closure elements, 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 through a measured length of pipe between two sphere detection devices. Knowing the transit time and the exact volume between the 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 through the line.

Mill Certificates

Certificates, provided by the steel mill, indicate the chemical analysis and physical properties of a specific batch of steel. "Mill Certs" are usually required only for pressure-containing parts. The customer's need for such "Mill Certs" must be made known when the order is first placed, otherwise is it not possible to trace a valve part back to the mill. *See "Heat Analysis".*

Mill Test

All tests required by the material specification. Usually includes both the heat analysis (chemical) and the physical properties, and sometimes impact tests.

Mill Test Reports

See "Mill Certificates".

Modulus (or Coefficient) of Elasticity

The ratio between a force per unit area (stress) that acts to deform a body and the corresponding fractional deformation (strain) produced by the stress.

Mold

A hollow cavity (frequently in packed sand) for giving a desired shape to a material in a molten or plastic state. Used in making metal castings.

Monitoring (or Monitor Service)

A field procedure whereby two valves – usually regulators – are installed in series and adjusted in such a manner that, should the primary regulator fail, the standby regulator will automatically take over at a slightly higher pressure setting.

NACE – National Association of Corrosion Engineers

This technical association publishes papers, articles, and standards on all aspects of corrosion and has written the definitive standard for valve materials for sour gas service.

NDE – Non-Destructive Examination

See "Non-Destructive Tests".

NEMA – National Electrical Manufacturers Association

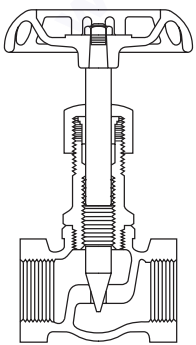
An association that has set up guidelines for the manufacture of electrical equipment. Generally applicable to specifications for switches, etc., for electric operators.

NPT – National Pipe Tapered

A uniform standard governing the dimensions of tapered pipe threads.

Needle Valve

A type of small valve, used for flow metering, having a tapered needlepoint plug or closure element and a seat having a small orifice.



NEEDLE VALVE

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.

NIPPLE WITH THREADED ENDS

Nitrogen/Helium Test

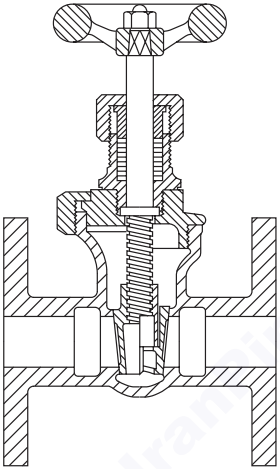
A pressure test conducted using nitrogen or helium (inert gases) instead of air, water, or other gases to prevent any danger of fires or explosions. Generally specified by the purchaser when buying a valve or regulator product.

Non-Destructive Tests

Those inspection tests that are not destructive to the valve structure or function. *See "Radiographic Inspection", "Liquid Penetrant Inspection", "Magnetic Particle Inspection", "Ultrasonic Inspection".*

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.



WEDGE GATE VALVE WITH NON-RISING STEM

Normally Closed Solenoid Valve

An electrically operated valve whose inlet orifice is closed when the solenoid coil is not energized. Energize to open. *See "Solenoid Valve".*

Normally Open Solenoid Valve

An electrically operated valve whose inlet orifice is open when the solenoid coil is not energized. Energize to close. *See "Solenoid Valve".*

OCMA – Oil Companies Materials Association

An association of British oil companies which has written a standard for fire-safe testing of soft-seated valves. *See "Fire-Safe".*

OD – Outer Diameter

The measurement of the outermost diameter of a circular part.

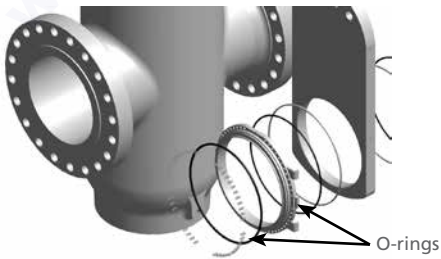
Oldham Coupling

A double slider connection used to connect shafts.

OLDHAM COUPLING

O-Ring

An elastomeric or synthetic seal ring of circular cross section.



Operating Time

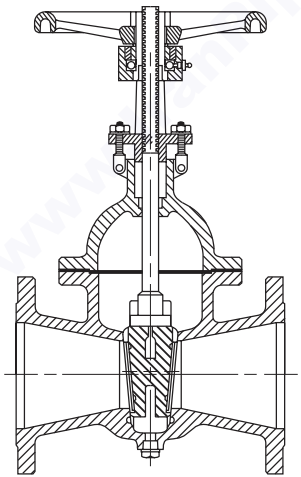
The time required for a power operator to stroke the valve from a fully open to fully closed position or vice versa.

Operator

A device that converts manual, hydraulic, pneumatic, or electrical energy into mechanical motion to open and close a valve. *See "Power Operator", "EMO", "GO", "HWO", "MGO", "MO".*

OS&Y – Outside Screw and Yoke

A valve in which the fluid does not come in contact with the stem threads. The stem sealing element is between the valve body and the stem threads.



WEDGE GATE VALVE WITH OS&Y

Outer Seat Ring

The outer metal piece of a two-piece seat ring unit. *See "Inner Seat Ring".*

PSI (psi)

An abbreviation for "pounds per square inch". The force per unit area exerted against a resisting body.

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".*

Packing Gland

See "Gland".

Pattern

A duplicate or copy, usually wooden, of a part to be cast. Used to form the mold into which molten metal is poured.

Peak Shaving

When daily usage of natural gas is charted on graphs, it will show high peaks (of usage) during the winter months. These peaks can be "shaved" (averaged out) when the daily consumption is augmented with standby supplies of synthetic natural gas, propane, or methane.

Phenolic Coating

A thermo-setting resin applied to valve interiors and/or exteriors to inhibit corrosion. A plastic material.

PIG (Pipeline Inspection Gauge)

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

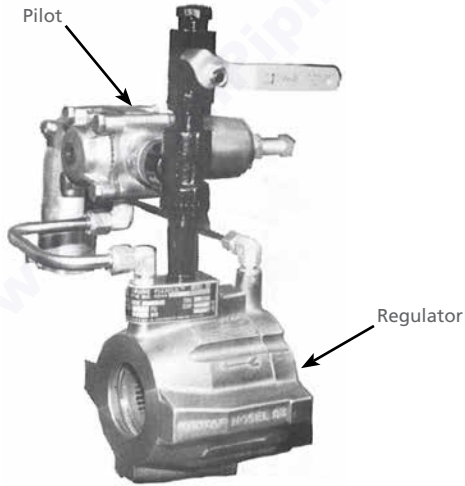
24" PIG WITH URETHANE BLADES

Pilot

A spring-loaded pressure regulator used to control the pressure and flow of other larger pressure regulators or instruments.

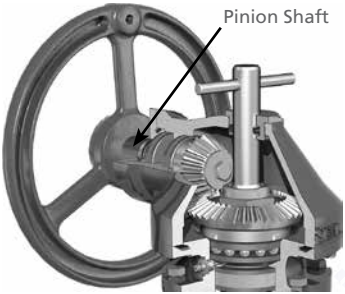
Pilot-Operated Regulator

A regulator that is controlled by a second small-volume, high-accuracy regulator or pilot. This arrangement has the advantages of improving performance reducing the effects of unbalanced pressure and droop. The number of possible applications also are increased since a wide range of pilot configurations are feasible.



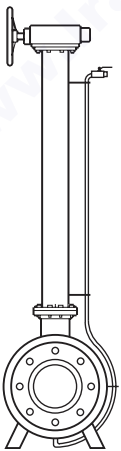
Pinion Shaft

The external input shaft of certain gear operators which drives the internal reduction gearing. The pinion shaft can accept a handwheel or power operator.



Pinion Shaft Extension

On a buried valve, the gear operator pinion shaft must be extended above grade to permit the valve to be operated.



Piston Effect

The sealing principle involved in utilizing line pressure to effect a seal across the floating seats of some valves.

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. Worm gears of gear operators also are identified by pitch and lead. Speed of operation and torque required are related to pitch and lead.

Plastics

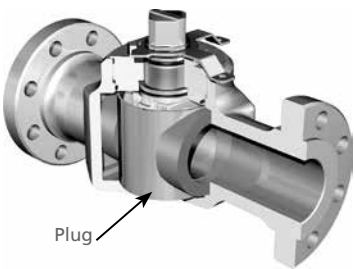
A broad classification covering a variety of non-metallic, synthetic, or organic materials capable of being molded or formed into desired shapes. Also used as a protective coating for valves.

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.

Plug Valve

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



Pneumatic

Pertaining to, or using, air or gas.

Poly Pak Stem Seal (A Parker Seal Company Product)

An O-ring energized lip seal that replaces the O-ring stem seal in certain gate valves. Also used for stem seals in some ball valves. *See "Lip Seal".*

Port

See "Bore".

Position Indicator

Any external device that visually indicates the open and closed position of a valve. *See "Stem Indicators".*

Power Operator

Powered valve operators are of the following general types: electric motor, pneumatic or hydraulic motor, and/or pneumatic, or hydraulic cylinder. Operators can either be adapted directly to the valve stem or side-mounted on existing gear or scotch yoke operators.

Pressure

See "PSI".

Pressure Differential

See "Differential Pressure".

Pressure Drop

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

Pressure-Reducing Regulator

Regulator designed to control downstream pressure. *See "Regulator".*

Pressure Switch

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

Pressure Test

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

Product Analysis

A verification conducted by the steel manufacturer to assure that the chemical composition of received material coincides with the heat analysis and with requirements of the applicable specification.

Product Standardization

The process by which purchasers ensure consistency of a product's quality by the approval of the vendors' standardized documentation. This is normally used as the basis for blanket purchase agreements.

Proof Pressure

A hydrostatic test pressure, usually 1-1/2 times the rated working pressure, applied to an assembled valve to verify the structural integrity of the pressure-containing parts. Synonymous with hydrostatic shell test. (Ref. API 6D).

Protective Sleeves

A circular "pipe-like" sleeve inserted in place of the ball and seats of a top-entry ball valve. This protective sleeve remains in place inside the valve during valve installation and ultimate pigging of a pipeline to clear debris from the line before placing the pipeline into service. Once the pipeline has been purged of all debris, the protective sleeve is removed entirely from the ball valve cavity, and operating trim (i.e., ball and seats) is then installed for normal service conditions.

Pulsation

Rhythmical throbbing or vibrating. In pipelines, a flow or pressure oscillation that is identically repeated in every fixed time interval. Pulsation is an inherent characteristic of reciprocating gas compressors and reciprocating liquid pumps. Pressure and flow pulsations interact with piping systems to cause vibration, metering errors, and potential equipment damage.

Pump

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

Pump Control Valve

A ball valve that is not meant for on-off service, but whose specific function is to control flow and prevent cavitations in pumps on liquid pipelines.

Pups

See "Transition Piece".

Qualification Test

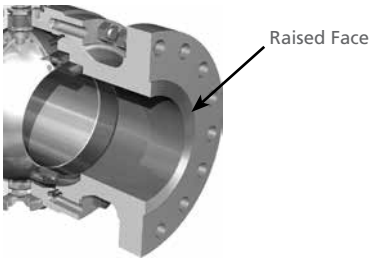
An investigation, independent of a purchasing function, that is performed on a product to determine whether or not the product conforms to all of the requirements of a particular specification. This is generally done by a third-party independent to qualify a product for a specific application.

Quality Assurance

Planned regular and/or preventive actions which are used to ensure that materials, products, or services will meet specified requirements.

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.

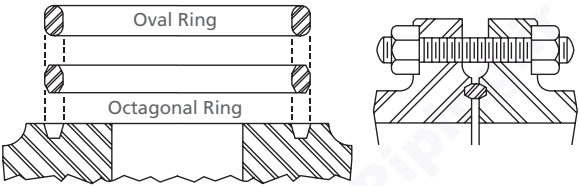


RPM – Revolutions Per Minute

Rotational speed, turns per minute. For example, the RPM delivered by a power operator to the pinion shaft of a gear operator.

RTJ – Ring-Type Joint

A flange connection using a specially shaped soft metal ring as a gasket. Generally used on high-pressure valves and not widely used in the pipeline industry.



Radiographic Inspection

An X-ray NDE procedure for locating flaws in welds, casting, and fabricated parts.

Ratchet Drive

A shaft or valve that is operated by means of a ratchet mechanism. The ratchet delivers an intermittent stepped rotation through a gear in one direction only.

Reduced Port (or Reduced Bore)

See "Venturi Valve".

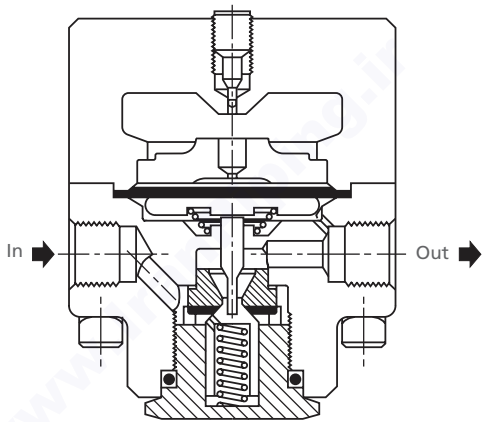
Regular Port Valve

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

Hence, it corresponds to a Venturi or reduced-bore valve of the same nominal pipe size. Venturi ball valves often are a logical alternative to plug valves with advantages in price torque and low maintenance.

Regulator

A throttling valve that 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. Often installed on the body cavity of ball and gate valves to relieve thermal overpressure in liquid services.
See "BRV" and Section 2.

Remote Control

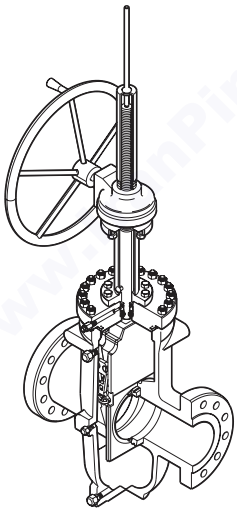
The operation of a valve or other flow-control device from a point at a distance from the device being controlled. Can be accomplished by electrical, pneumatic, or hydraulic means.

Resilient Seat

A valve seat containing a soft seal, such as an O-ring, to ensure tight shutoff.

Rising Stem

A valve stem that rises as the valve is opened.

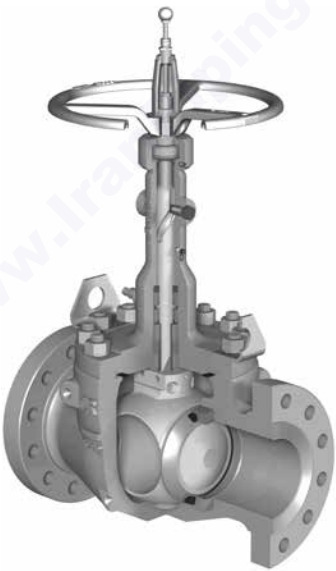


RISING STEM GATE VALVE

Rising Stem Ball Valve

A single-seated ball valve that is designed to seal by using the valve's stem to mechanically wedge the valve's ball into a stationary seat, affecting a bubble-tight seal. The valve's stem operates through a guide sleeve assembly that guides the stem through a quarter turn of rotation as the stem is raised or lowered by a handwheel (or actuator).

The mechanical action of the stem moves the ball away from the seat prior to the 90-degree rotation of the ball. The design provides lower operating torques and longer seat life while assuring bubble-tight shutoff.



ORBIT® RISING STEM BALL VALVE

Road Box

A concrete or metal box with a removable cover, enclosing and providing access to valves installed in buried lines alongside roads or streets. The valves are operated by removing the box cover and inserting a long-handled T wrench which engages a 2" square nut attached to the valve stem or to the pinion shaft of geared valves.

Rockwell Hardness Number

A numerical expression of the hardness of a metal as determined with a Rockwell Hardness Tester. There are several hardness scales. The most commonly used are the Rockwell B scale for soft metals and the Rockwell C scale for hard materials.

Rupture Disc (or Blowout Disc)

An emergency overpressure relief device, a relatively thin diaphragm designed to burst at a specified pressure. It cannot be reset, but must be replaced after rupture event.

SNG – Synthetic Natural Gas

A substitute natural gas made from the by-products of chemical plants and refineries. *See "Coal Gasification"*.

SPDT – Single-Pole, Double-Throw

See "SPST".

SPST – Single-Pole, Single-Throw

Refers to the function of an electrical switch often used in the control system of electric valve operators.

SSIV – Subsea Isolation Valve

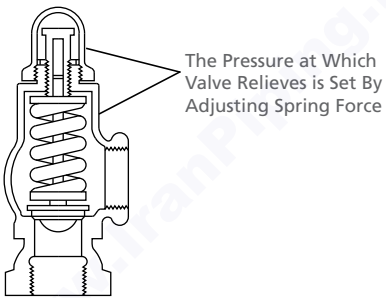
A valve used underwater, generally in a manifold that will close and isolate a particular pipeline or process in an emergency.

SY – Scotch Yoke

See "Scotch Yoke Operator".

Safety Valve

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



SPRING-LOADED SAFETY VALVE

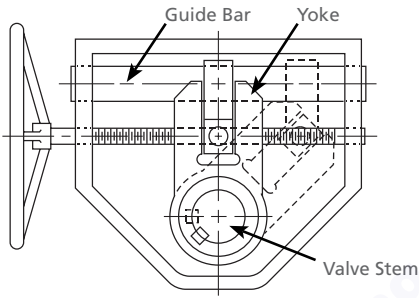
Schedule

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 for use on quarter-turn valves using a scotch yoke mechanism rather than gears. The scotch yoke

has a torque output at the beginning and end of its stroke that is generally twice the magnitude of the torque output in the center of its stroke.



SCOTCH YOKE OPERATOR

Screwed Ends

Internally threaded end connections supplied on some valves. Usually tapered pipe threads. *See "NPT".*

Seal, Dynamic

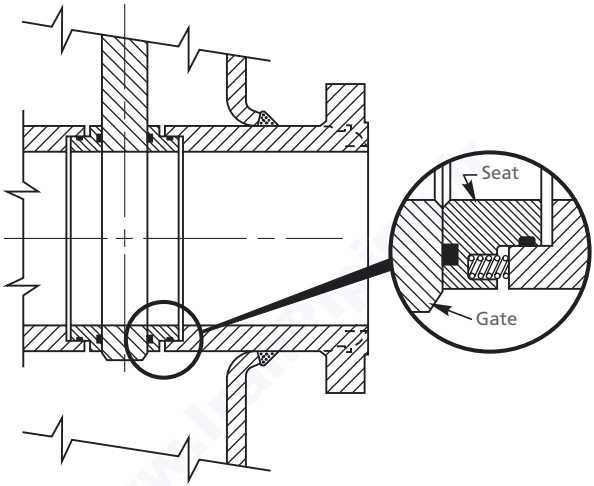
A sealing element used between parts that have relative motion, e.g., stem seals, seat seal O-rings, etc.

Seal, Static

A sealing element used as a gasket between two non-moving parts, e.g., valve bonnet O-rings, ball valve body O-rings, flange gaskets, etc.

Seat

That part of a valve against which the closure element (gate, ball) affects a tight shutoff. In many ball valves and gate valves, it is a floating member usually containing a soft seating element.



SLAB GATE POSITIONED BETWEEN SEAT RINGS

Self Relieving

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

Separator

A special tank used to separate gas from oil in some crude oil gathering systems.

Short Gate

A gate valve wherein the seat rings contact the gate only in the closed position. Such valves are not through-conduit, as the gate is completely withdrawn from the flow area in the open position.

Short-Pattern Valve

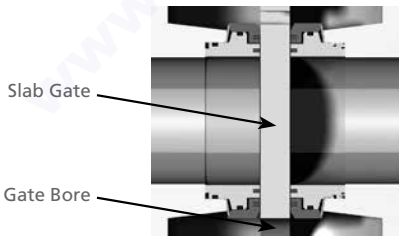
A valve with face-to-face dimensions less than the API 6D standard.

Shut-off Valve

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

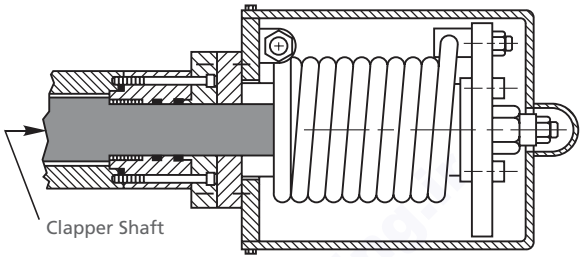
Slab Gate

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 shutoff.



Slam Retarder

A device to prevent the clapper of a check valve from slamming as it closes upon flow reversal. Hydraulic damping cylinders, rotary vanes, and torsional springs are all used for this purpose.



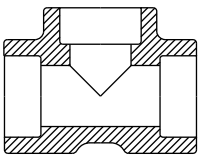
TORSIONAL SPRING SLAM RETARDER

Slurry Service

An application involving a flow medium consisting of small solid particles suspended in a liquid. Coal slurry, consisting of about equal parts of coal and water, is transported by pipeline from coal mines to plants where the coal is dewatered and burned. A specially modified GROVE® B5 ball valve is offered for this service.

Socket End

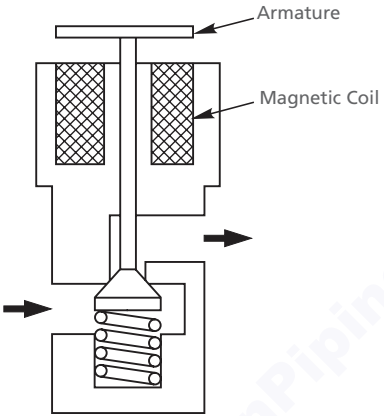
An end connection in which a pipe or tube is inserted into a counterbored hole and then brazed or fillet-welded.



TEE WITH SOCKET ENDS

Solenoid Valve

A small electrically operated valve used in the control piping of powered hydraulic or pneumatic cylinder operators.



NORMALLY CLOSED – ENERGIZED TO OPEN

Sour Gas

Natural gas containing significant amounts of H_2S. Requires special trim.

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).

Sphere-Lok (a GROVE® product)

A ball valve having a blind pocket in the ball rather than a through hole. The valve will catch and hold a metal sphere and then launch it down the pipe. Used in meter prover systems to accurately measure flow rates and calibrate flow meters. *See "Two-Way Sphere-Lok", "Meter Prover".*

Spool Piece

See "Adapter Spool".

Spur Gear

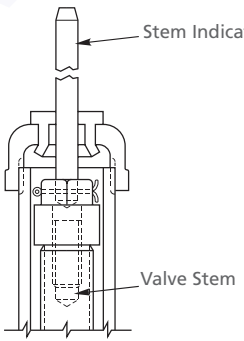
The simplest of gears. In a gear set, the pinion and ring gear are aligned on parallel shafts.

Stem

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

Stem Indicator (or VPI – Visible 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.

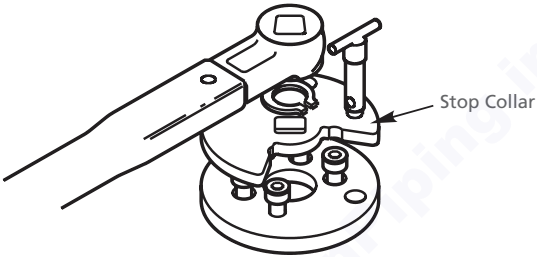


Stem Nut

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

Stop Collar

The collar on a ball valve that restricts the ball to 90 degrees of rotation from the fully closed position. *See "Key Stop".*



Stopple (or Stop Off)

A procedure used in the repair of a pipeline to isolate a section of line in the absence of a shut-off valve. After welding a flanged saddle to the pipe, the line is "hot tapped"and an expanding resilient plug is inserted into the pipe bore. When the repair is completed, the plug is withdrawn and a valve, installed on the saddle flange, is closed.

Strain Gauge

An instrument used to measure small or minute distortions caused by stress forces in mechanical components.

Street Ell

A 90-degree pipe fitting with male and female threaded ends.

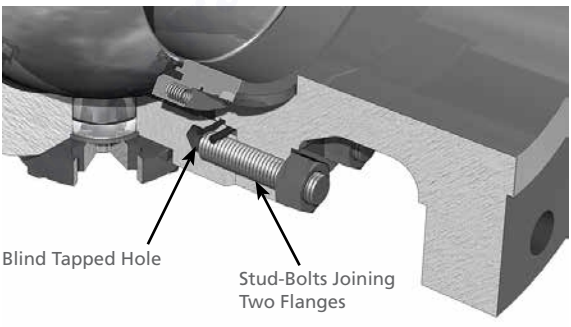
90-DEGREE STREET ELL

Stress

An engineering parameter used in the design of valves. The value of unit force (psi) produced within a material as the result of an applied force or load. Developed stress must be held well below the yield strength of the material.

Stud

A bolt, threaded on both ends, often used in bolting together two members, one of which has blind tapped bolt holes.



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.

Surge

To rise suddenly to an excessive or abnormal value; a transient sudden rise of pressure in a pipeline. Pipeline surges can be positive or negative and are caused most frequently by the sudden closure of a block valve or emergency shutdown of a pump. Surge pressure in excess of the rated capacity of a pipeline can cause ruptures of the piping system. *See Section 2.*

Surge Reliever

A valve designed to relieve pressure surges in liquid pipelines, thus preventing line rupture due to transient pressures exceeding design limits of the pipe. A special flexible tube valve can function as a fast-acting surge reliever.

Swage

A tool for bending or forming cold metal to a required shape.

Sweet Gas

Natural gas having no significant H_2S 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".*

System Engineering

That engineering approach which deals with the design and integration of multiple components and controls into an assembled piping complex to accomplish a specified function or functions.

Tee

A pipe or tubing fitting with a side outlet at right angles.

TEE

Tensile Strength

The highest tensile stress that a material can withstand before failure or rupture occurs with force being applied in a direction tending to elongate the material.

Tensile Test

A test performed on specially machined specimens taken from material in its delivered condition, to determine physical properties, e.g., yield strength, ultimate strength, and percent elongation.

Tension Test

See "Tensile Test".

Test Certificates

Documents provided by a manufacturer certifying that required tests were performed.

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.

Through-Conduit

An expression characterizing valves when in the open position, wherein the bore presents a smooth uninterrupted interior surface across seat rings and through 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.

Thrust

Force applied to a part in a particular direction, e.g., thrust on 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 accessing its internals by removing a top portion of the unit.

TOP-ENTRY BALL VALVE

Torque

The turning effort required to operate a valve. Usually expressed in lb-ft and in reference to the stem nut, handwheel, or operator pinion shaft.

Torque Switch

An electrical device on a motor operator that cuts off power to the operator when allowable torque is exceeded, thus preventing damage to the valve and/or the operator.

Torsional Spring

A coiled spring that exerts a force by twisting about its axis rather than by compression or elongation. The torsional spring in a check valve slam retarder is restrained at one end and fastened to the clapper shaft on the other end. As the clapper opens, the spring resists the motion, creating a closing force. During a rapid decrease in flow rate, the clapper is urged toward the closed position and is virtually closed just prior to the instant of actual flow reversal, thus slamming is avoided. *See "Slam Retarder".*

Transition Piece

A length of pipe that is welded to a valve hub or closure. Generally provided by the customer, it serves as a transition from the customer's piping to the valve to compensate for differences in material or size.

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.

Trim

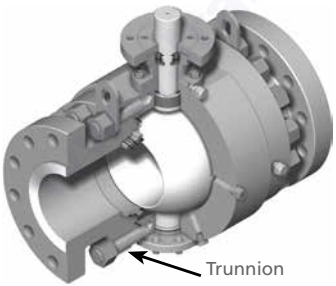
Commonly refers to the valve's working parts and to their materials.

Triple Eccentric (or Butterfly Valve)

A particular design of a butterfly valve where the stem is located behind the disc and below the centerline of the disc, and its cone axis is offset from the centerline of the disc. This particular design is capable of a very tight shutoff at temperatures well above 1000° F (538° C).

Trunnion

That part of a ball valve which holds the ball on a fixed vertical axis and about which the ball turns. The torque requirements of a trunnion mounted ball valve are significantly less than for a floating ball design.



Turns to Operate

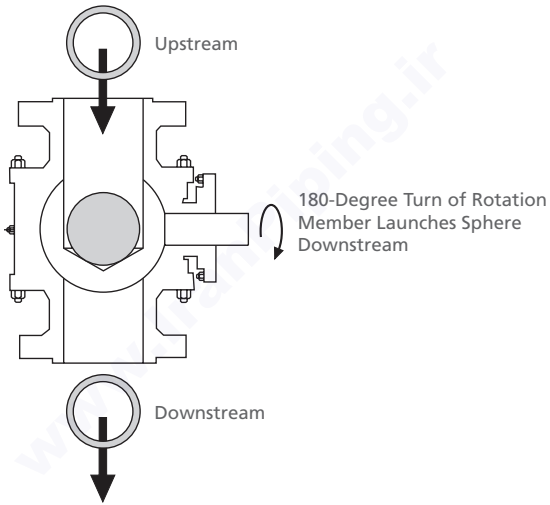
The number of complete revolutions of a handwheel or the pinion shaft of a gear operator required to stroke a valve from fully open to fully closed or vice versa.

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.

Two-Way Sphere-Lok

A Sphere-Lok with two ports. *See "Sphere-Lok".*



TWO-WAY SPHERE-LOK

U-Cup (Ring Packing)

A U cross-section ring located in the tail end of certain ball valve seats to retain the grease in an emergency seat seal system.

UL – Underwriters Laboratory

An impartial testing laboratory concerned with the safety of electrical components. Products surviving the tests are included on a certified listing of products by manufacturer. This does not imply UL approval.

Ultimate Strength

That stress at which a material will fail.
See "Tensile Test", "Burst Pressure".

Ultrasonic Inspection

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

Underground Storage

The storage of natural gas or other fluids underground.

Union Connection

A small three-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.

UNION CONNECTION

VDS – Valve Data Sheet

A data sheet defining the minimum level of a valve design, including the materials, testing, inspection, and certification requirements.

VPI – Visible Position Indicator

See "Stem Indicator".

Vacuum

A space from which air or gas has been exhausted until its pressure is less than atmospheric pressure, e.g., any pressure below 14.7 psi absolute.

Valve

A device that controls the flow of a liquid or gas in a conduit or pipeline.

Variable Orifice

A small variable profile valve put in a flowline and used with a pilot to restrict the flow into the pilot and make the pilot more or less sensitive to changing conditions.

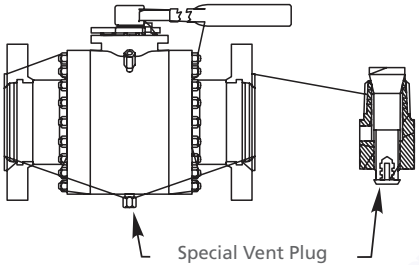
Velocity

The speed at which a fluid flows through a line in a specified direction. Usually expressed in ft/sec.

Vent Plug (or Vent Plug Assembly/Safety Vent Plug)

A special pipe plug having a small allen wrench-operated vent valve. These special plugs are located at the bottom of most ball valves. With the line valve closed (and under pressure), the body cavity pressure can be vented through this small valve to check the tightness of seat seals or to make minor repairs. Having vented the body pressure, the vent plug can be removed to blow out debris and foreign material or to flush the body cavity. On some gate valves,

the vent plug is installed on the bonnet for the sole purpose of venting the body. Such valves have separate drain valves. *See "Block-and-Bleed", "Drain Plug".*



Venturi Valve

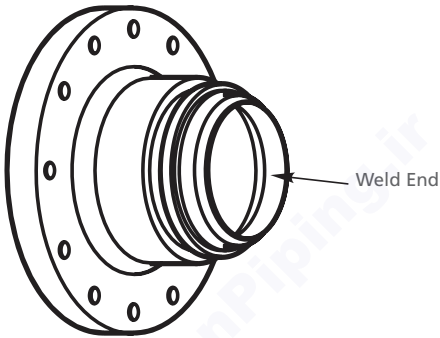
A reduced-bore valve. A valve having a bore smaller in diameter than the inlet or outlet. For example, an 8" x 6" x 8" ball valve has 8" inlet and outlet connections, while the ball and seats are 6". The flow through a Venturi valve will be reduced because of the smaller port. Venturi valves often can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

Viscosity

A measure of the internal friction of a fluid or the resistance of a flow. Two fluids of identical specific gravity may have quite different viscosities.

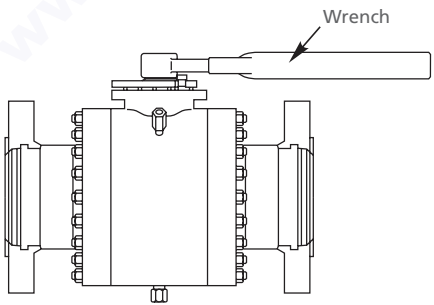
WE – Weld End

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.
See "End Bevel".



WO – Wrench Operated

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



WOG – Water-Oil-Gas

Used in connection with a pressure rating. Thus, 100 WOG indicates the rated pressure is 100 psi in water, oil, or gas service at normal ambient temperatures.

WP – Working Pressure

The maximum anticipated sustained operating pressure applicable to a pipe.

Wall Thickness

The thickness of the wall of a pressure vessel or the thickness of the wall of a pipe.

Water Hammer

The physical effect, often accompanied by loud banging, produced by pressure waves generated within the piping by a rapid change of velocity in a liquid system.

Wear Test

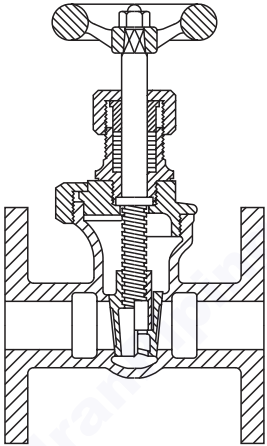
Verification of a component's resistance under specific wear conditions.

Weatherproof

Describes a valve operator or other device that is protected against intrusion of water, sand, dust, or other atmospheric contamination.

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.



WEDGE GATE

Weld End

See "WE", "End Bevel".

Weld Neck Flange

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

WELD NECK FLANGE

Weld Reducer

A reducing fitting used on weld end piping components to adapt from a large sized pipe to a smaller diameter pipe or vice versa.

WELD REDUCER

Worm Gears

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

WORM GEAR

X-Ray

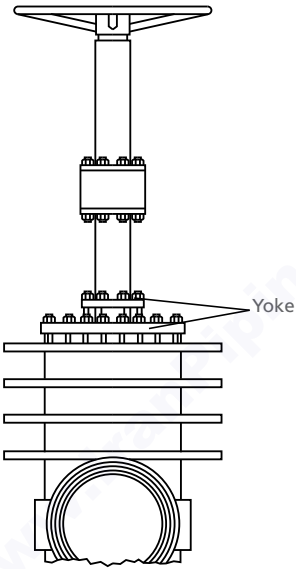
See "Radiographic Inspection".

Yield Strength

The limiting stress (psi) beyond which a material will sustain permanent deformation. Up to the yield strength, the material will spring back to its original dimension when the pressure is removed. Often in valves specs, the yield strength will be designated; this allows proper material selection.

Yoke

The part of a gate valve that serves as a spacer between the bonnet and the operator or actuator.



Control of Pressure Surges in Liquid Pipelines

Pressure surges in liquid pipelines occur as the result of rapid changes in flow rate that might be caused by sudden valve closure or pump stoppage. Surge pressure can be either positive or negative, each kind presenting its own set of problems to the pipeline designer.

Positive pressure surges, or spikes, can reach dangerous levels within fractions of a second of the triggering event. Peak pressures easily can exceed pipeline ratings and can occur at points in the line quite remote from the triggering event.

Surge relief valves placed at critical locations along the pipeline can be made to open and discharge liquid into holding tanks as surges start to build and thus maintain pipeline pressures at safe levels.

A flexible tube surge reliever is ideally suited for this service. This type of reliever is the ultimate in simplicity and reliability, featuring a synthetic rubber tube which functions as both pressure sensing means and the valve element.

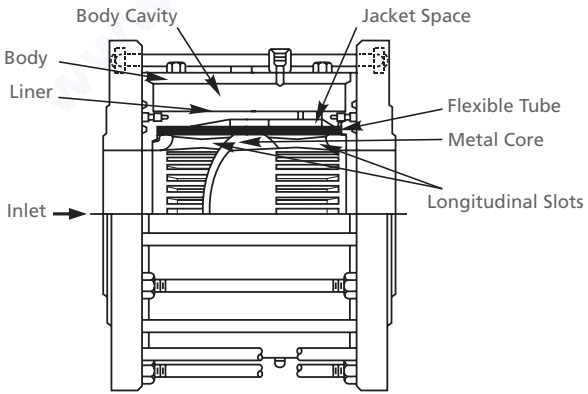
The tube, the valve's only moving part, opens smoothly and automatically within milliseconds to relieve a surge and then seals off drop-tight as the pressure subsides.

The mathematical treatment of surges in liquid pipelines is a complex study usually involving extensive computer analysis.

There are firms that specialize in pipeline surge analysis and are able to include mathematical models of the reliever in their calculations.

The surge reliever is designed to have an opening time in the low millisecond range when line pressure increases over set pressure. The body cavity/ jacket space is gas loaded (usually nitrogen) to a predetermined pressure. Rapid actuation is achieved by high speed transfer of the gas from the jacket space into the larger body cavity as the tube expands. The surge is relieved by the increase of the annular volume under the flexible tube as it expands and by discharge of line liquid when it opens. Minor pipeline surges are relieved without discharging liquid through the surge. A minor surge over set pressure causes the tube to expand on the inlet end, increasing the annular volume, but does not cause it to open.

The body cavity/jacket space can be pressurized to a desired set pressure and locked in, or a pressure regulator may be used to maintain pressure on top of the tube. If significant changes in ambient temperature are expected, a loading regulator is recommended to hold the jacket pressure constant.



FLEXIBLE TUBE SURGE RELIEVER (Surge Reliever)

SURGE RELIEF SYSTEM USING RELIEVERS

An engineered system for the control of pressure surge in a large liquid pipeline. This system consists of a number of surge relievers in parallel responding to the same control signal.

Section 3: Conversion Tables and Equivalents

To Convert	Multiply By	To Obtain
	A	
acre	43,560	sq ft
acre	4047	sq m
acre	0.001562	sq mile
acre	4840	sq yd
atm	76.0	cm of mercury (at 0° C)
atm	29.92	in. of mercury (at 0° C)
atm	1.0332	kg/sq cm
atm	10,330	kg/sq m
atm	14.7	lb/sq in.
	B	
bbl (US liquid)	31.5	gal
bbl (oil)	42.0	gal (oil)
bbl/d (oil)	0.02917	gal/min (oil)
bbl/hr (oil)	0.7	gal/min (oil)
bar	0.9869	atm
bar	1.020×10^{4}	kg/sq m
bar	2089	lb/sq ft
bar	14.5	lb/sq in.
barye	1.0	dy/sq cm
btu	10.41	L-atm
btu	1.055×10^{10}	erg
btu	778.2	ft-lb
btu	252.0	g-cal
btu	3.927×10^{-4}	hp-hr
btu	1055	joules
btu	0.252	kg-cal
btu	107.6	kg-m
btu	2.928×10^{-4}	kW-hr

To Convert	Multiply By	To Obtain
	B	
btu/hr	0.2162	ft-lb/sec
btu/hr	0.07	g-cal/sec
btu/hr	3.929×10^{-4}	hp
btu/hr	0.2931	watt
btu/min	12.96	ft-lb/sec
btu/min	0.02356	hp
btu/min	0.01757	kW
btu/min	17.57	watt
btu/sq ft/min	0.122	watt/sq in.
	C	
candlepower	12.5664	lumen
centares	1.0	sq m
° C (degrees)	(° C x 9/5) + 32	° F (degrees)
° C (degrees)	° C + 273.18	K (degrees)
cg	0.01	g
cL	0.3382	oz (fluid) US
cL	0.6103	cu in.
cL	2.705	drams
cL	0.01	L
cm	0.03281	ft
cm	0.3937	in.
cm	0.01	m
cm	10.0	mm
cm	10,000	µm
cm-dyn	0.00102	cm-g
cm-dyn	1.020×10^{-8}	m-kg
cm-dyn	7.376×10^{-8}	lb-ft
cm-g	980.7	cm-dyn

To Convert	Multiply By	To Obtain
	C	
cm-g	1.0×10^{-5}	m-kg
cm-g	7.233×10^{-5}	lb-ft
cm of mercury	0.01316	atm
cm of mercury	0.4461	ft of water
cm of mercury	136.0	kg/sq m
cm of mercury	0.1934	lb/sq in.
cm/sec	1.969	ft/min
cm/sec	0.0328	ft/sec
cm/sec	0.036	km/hr
cm/sec	0.0194	knots
cm/sec	0.6	m/min
cm/sec	0.02237	mile/hr
cm/sec	3.728×10^{-4}	mile/min
cm/sec/sec	0.0328	ft/sec/sec
cm/sec/sec	0.036	km/hr/sec
cm/sec/sec	0.01	m/sec/sec
cm/sec/sec	0.0224	mile/hr/sec
cp	0.01	gr/cm-sec
cp	6.72×10^{-4}	lb/ft-sec
circumference	6.283	radian
cc	3.531×10^{-5}	cf
cc	0.06102	cu in.
cc	1.308×10^{-6}	cu yd
cc	0.001	L
cc	0.001057	qt (US liquid)
cf	0.178	bbl (oil)
cf	28,320	cu cm
cf	1728	cu in.
cf	0.02832	cu m
cf	0.03704	cu yd

To Convert	Multiply By	To Obtain
	C	
cf	7.48052	gal (US liquid)
cf	28.32	L
cf/min	62.4	lb water/min
cf/sec	448.8	gal/min
cu in.	16.39	cc
cu in.	5.787×10^{-4}	cf
cu in.	1.639×10^{-5}	cu m
cu in.	2.143×10^{-5}	cu yd
cu in.	0.01639	L
cu m	6.28	bbl (oil)
cu m	8.38	bbl (US liquid)
cu m	1,000,000	cu cm
cu m	35.31	cf
cu m	61,023	cu in.
cu m	1.308	cu yd
cu m	264.2	gal
cu m/hr	151.0	b/d (oil)
cu m/hr	4.403	gal/min
cu yd	27.0	cf
cu yd	46,656	cu in.
cu yd	0.7646	cu m
	D	
dL	0.1	L
dm	0.1	m
degree (angle)	0.01745	radian
dag	10.0	g
daL	10.0	L
dam	10.0	m

To Convert	Multiply By	To Obtain
	D	
dram	1.7718	g
dram	27.344	grain
dram	0.0625	oz
dyn/sq cm	0.01	erg/sq mm
dyn/sq cm	9.869×10^{-7}	atm
dyn/sq cm	2.953×10^{-5}	in. of mercury (at 0° C)
dyn/sq cm	4.015×10^{-4}	in. of water (at 4° C)
dyn	0.00102	g
dyn	1.0×10^{-7}	J/cm
dyn	1.0×10^{-5}	J/m (newtons)
dyn	1.020×10^{-6}	kg
dyn	7.233×10^{-5}	pdl
dyn	2.248×10^{-6}	lb
dyn/sq cm	1.0×10^{-6}	bar
	E	
erg/sec	1.0	dyn-cm/sec
erg	9.486×10^{-11}	btu
erg	1.0	dyn-cm
erg	7.376×10^{-8}	ft-lb
erg	2.389×10^{-8}	g-cal
erg	0.00102	g-cm
erg	3.7250×10^{-14}	hp hr
erg	1.0×10^{-7}	J
erg	2.389×10^{-11}	kg-cal
erg	1.020×10^{-5}	kg m
erg	2.773×10^{-14}	kW-hr
erg	2.773×10^{-11}	W-hr
erg/sec	5.668×10^{-9}	btu/min

To Convert	Multiply By	To Obtain
	E	
erg/sec	4.426×10^{-6}	ft-lb/min
erg/sec	7.3756×10^{-8}	ft-lb/sec
erg/sec	1.341×10^{-10}	hp
erg/sec	1.433×10^{-9}	kg-cal/min
erg/sec	1.0×10^{-10}	kW
EJ	1.0×10^{18}	J
	F	
fathom	1.8288	m
fathom	6.0	ft
ft	30.48	cm
ft	0.3048	m
ft	1.894×10^{-4}	miles (stat.)
ft of water	0.8826	in. of mercury
ft of water	0.03048	kg/sq cm
ft of water	0.4335	lb/sq cm
ft/min	0.01667	ft/sec
ft/min	0.01136	mile/hr
ft/sec	0.6818	mile/hr
ft/sec/sec	0.3048	m/sec/sec
ft-lb	0.001286	btu
ft-lb	0.1383	kg-m
ft-lb/min	0.001286	btu/min
ft-lb/min	3.030×10^{-5}	hp
ft-lb/min	2.260×10^{-5}	kW
ft-lb/sec	0.001818	hp
ft-lb/sec	0.001356	kW

To Convert	Multiply By	To Obtain
	G	
gal	3785	cu cm
gal	0.1337	cf
gal	231.0	cu in.
gal	0.003785	cu m
gal	3.785	L
gal of water	8.331	lb of water
gal/min	34.28	b/d (oil)
gal/min	0.002228	cf/sec
gal/min	0.06308	L/sec
gi (US)	0.25	pt (liquid)
g	980.7	dyn
g	15.43	grain (troy)
g	0.001	kg
g	0.03527	oz (avoir)
g	0.002205	lb
g/cm	0.0056	lb/in.
g/cu cm	62.43	lb/cf
g/cu cm	0.03613	lb/cu in.
g/L	0.06247	lb/cf
g/sq cm	2.0481	lb/sq ft
g-cal	0.003968	btu
g-cal	4.184×10^{7}	erg
g-cal	3.086	ft-lb
g-cal	1.5596×10^{-6}	hp-hr
g-cal	1.162×10^{-6}	kW-hr
g-cal	0.001162	W-hr
g-cal/sec	14.286	btu/hr
g-cm	9.297×10^{-8}	btu
g-cm	980.7	erg
g-cm	9.807×10^{-5}	J

To Convert	Multiply By	To Obtain
	G	
g-cm	2.343×10^{-8}	kg-cal
g-cm	1.0×10^{-5}	kg-m
	H	
ha	2.471	acre
ha	107,600	sq ft
hg	100.0	g
hl	100.0	L
hp	42.44	btu/min
hp	33,000	ft-lb/min
hp	550.0	ft-lb/sec
hp	10.7	kg-cal/min
hp	745.7	watt
hp-hr	2,547	btu
hp-hr	1.98×10^{6}	ft-lb
hp-hr	2.737×10^{5}	kg-m
hp-hr	0.7457	kW-hr
	I	
in.	2.54	cm
in.	0.0254	m
in.	25.4	mm
in. of mercury	0.03342	atm
in. of mercury	1.133	ft of water
in. of mercury	0.03453	kg/sq cm
in. of mercury	0.4912	lb/sq in.
in. of water	0.002458	atm
in. of water	0.07355	in. of mercury
in. of water	0.00254	kg/sq cm
in. of water	0.03613	lb/sq in.

To Convert	Multiply By	To Obtain
	J	
J	9.486×10^{-4}	btu
J	1.0×10^{7}	erg
J	1.0×10^{-18}	EJ
J	0.7376	ft-lb
J	2.389×10^{-4}	kg-cal
J	0.102	kg-m
J	2.778×10^{-4}	watt-hr
J/cm	1.020×10^{4}	g
J/cm	1.0×10^{7}	dyn
J/cm	100.0	J/m (newtons)
J/cm	723.3	pdl
J/cm	22.48	lb
	K	
K Pascal (KPa)	0.145	lb/sq in.
kg	980,665	dyn
kg	1,000	g
kg	2.2046	lb
kg	0.001102	ton (short)
kg/cu m	0.06243	lb/cf
km/cu m	3.613×10^{-5}	pounds/cu in.
kg/mm	0.672	lb/ft
kg/sq cm	9.807×10^{5}	dyn/sq cm
kg/sq cm	0.9678	atm
kg/sq cm	32.8	ft of water
kg/sq cm	28.96	in. of mercury
kg/sq cm	14.22	lb/sq in.
kg/sq m	9.678×10^{-5}	atm
kg/sq m	9.807×10^{-5}	bar

To Convert	Multiply By	To Obtain
kg/sq m	0.003281	ft of water
kg/sq m	0.002896	in. of mercury
kg/sq m	0.001422	lb/sq in.
kg/sq m	98.067	dyn/sq cm
kg-cal	3.968	btu
kg-cal	3086	ft-lb
kg-cal	0.001163	kW-hr
kg-cal/min	51.43	ft-lb/sec
kg-cal/min	0.09351	hp
kg-cal/min	0.06972	kW
kg-m	0.009296	btu
kg-m	7.233	ft-lb
kL	1000	L
kL	35.316	cf
kL	264.18	gal (US liquid)
kL	1.0×10^5	cm
km	3281	ft
km	1000	m
km	0.6214	mile (statute)
km/hr	27.78	cm/sec
km/hr	54.68	ft/min
km/hr	0.9113	ft/sec
km/hr	16.67	m/min
km/hr	0.6214	mile/hr
kW	56.92	btu/min
kW	44,260	ft-lb/min
kW	737.6	ft-lb/sec
kW	1.341	hp
kW	14.34	kg-cal/min
kW	1000	watt

To Convert	Multiply By	To Obtain
	K	
kW-hr	3413	btu
kW-hr	2.655×10^{6}	ft-lb
kW-hr	1.341	hp-hr
kW-hr	860.0	kg-cal
kW-hr	3.671×10^{5}	kg-m
kt	1.8532	km/hr
kt	1.151	statute mile/hr
	L	
lb (avoir)	256.0	dr (avoir)
lb (avoir)	7,000	grain
lb (avoir)	453.6	g
lb (avoir)	0.4536	kg
lb (avoir)	16.0	oz (avoir)
lb (avoir)	14.58	oz (troy)
lb (avoir)	1.2153	lb (troy)
lb (avoir)	5.0×10^{-4}	ton (short)
lb (troy)	5,760	grain
lb (troy)	373.24	g
lb (troy)	13.166	oz (avoir)
lb (troy)	12.0	oz (troy)
lb (troy)	240.0	dwt (troy)
lb (troy)	0.8229	lb (avoir)
lb (troy)	3.6735×10^{-4}	ton (long)
lb (troy)	3.7324×10^{-4}	ton (metric)
lb (troy)	4.1143×10^{-4}	ton (short)
lb of air	13.1	cf
lb of water	0.01602	cf
lb of water	27.68	cu in.

To Convert	Multiply By	To Obtain
	L	
lb of water	0.1198	gal
lb of water/hr	0.002	gal/min
lb of water/min	2.670×10^{-4}	cf/sec
lb-ft	0.1383	m-kg
lb/cf	0.01602	g/cu cm
lb/cf	16.02	kg/cu m
lb/cf	5.787×10^{-4}	lb/cu in.
lb/cu in.	27.68	g/cu cm
lb/cu in.	2.768×10^{4}	kg/cu m
lb/cu in.	1728	lb/cf
lb/ft	1.488	kg/m
lb/in.	178.6	g/cm
lb/sq ft	0.01602	ft of water
lb/sq ft	0.01414	in. of mercury
lb/sq ft	4.882	kg/sq m
lb/sq ft	0.006944	lb/sq in.
lb/sq ft	0.06804	atm
lb/sq ft	2.307	ft of water
lb/sq ft	2.036	in. of mercury
lb/sq ft	703.1	kg/sq m
league	3.0	mile (approx)
light year	5.9×10^{12}	mile
L	1000	cu cm
L	0.03531	cf
L	61.03	cu in.
L	0.001	cu m
L	0.001308	cu yd
L	0.2642	gal (liquid)
L	2.113	pint (liquid)
L	1.057	quart (liquid)

To Convert	Multiply By	To Obtain
	L	
L/min	5.886×10^{-4}	cf/sec
L/min	0.004403	gal/sec
L/min	0.2642	gal/min
L/sec	15.852	gal/min
lumen	0.07958	spherical candle power
lumen/sq ft	1.0	ft-candle
	M	
m	100.0	cm
m	3.281	ft
m	39.37	in.
m	0.001	km
m	6.214×10^{-4}	mile (statute)
m	1000	mm
m	1.094	yd
m of water	1.421	lb/sq in.
m/min	1.667	cm/sec
m/min	3.281	ft/min
m/min	0.05468	ft/sec
m/min	0.06	km/hr
m/min	0.03728	mile/hr
m/sec	196.8	ft/min
m/sec	3.281	ft/sec
m/sec	3.6	km/hr
m/sec	0.06	km/min
m/sec	2.237	mile/hr
m-kg	7.233	lb-ft
µm	1.0×10^{6}	m
mile (statute)	1.609×10^{5}	centimeters

To Convert	Multiply By	To Obtain
	M	
mile (statute)	5280	ft
mile (statute)	1.609	km
mile (statute)	1760	yd
mile/hr	44.7	cm/sec
mile/hr	88.0	ft/min
mile/hr	1.467	ft/sec
mile/hr	1.6093	km/hr
mile/hr	0.8684	kt
mile/hr	26.82	m/min
mile/hr	0.01667	mile/min
mile/min	2682	cm/sec
mile/min	88.0	ft/sec
mile/min	1.6093	km/min
mile/min	60.0	mile/hr
milliers	1000	kg
mg	0.001	g
mg/L	1.0	part/million
mL	0.001	L
mm	0.1	cm
mm	0.03937	in.
mm	0.001	m
million gal/day	1.5472	cf/sec
mils	0.00254	cm
mils	0.001	in.
miner's in.	1.5	cf/min
min (angles)	0.01667	degrees
min (angles)	2.909×10^{-4}	radian
MYG	10.0	kg
MYM	10.0	km
mW	10.0	kW

To Convert	Multiply By	To Obtain
	N	
nail	2.25	in.
N	1.0×10^5	dyn
N	0.2248	lb
N·m	0.7376	ft/lb
N·m	8.851	in-lb
	O	
oz (avoir)	16.0	dr
oz (avoir)	437.5	grain
oz (avoir)	28.349	g
oz (avoir)	0.0625	lb
oz (avoir)	0.9115	oz (troy)
oz (fluid)	1.805	cu in.
oz (fluid)	0.02957	L
oz (troy)	480.0	grain
oz (troy)	31.103	g
oz (troy)	1.097	oz (avoir)
oz (troy)	20.0	dwt (troy)
oz (troy)	0.08333	lb (troy)
oz/sq in.	0.0625	lb/sq in.
	P	
pace	30.0	in.
parsec	1.9×10^{13}	mile
parsec	3.084×10^{13}	km
part/million	0.0584	grain/US gal
part/million	0.07016	grain/imp gal
part/million	8.345	lb/million gal
pascal	1.45×10^{-4}	lb/sq in.

To Convert	Multiply By	To Obtain
	P	
Pa	1.0	N/sq m
peck (US)	0.25	bushel
peck (US)	537.6	cu in.
peck (US)	8.8096	L (dry)
peck (US)	8.0	qt (dry)
pt (dry)	33.6	cu in.
pt (dry)	0.50	qt (dry)
pt (dry)	0.5506	L
pt (liquid)	473.2	cu cm
pt (liquid)	0.01671	cf
pt (liquid)	28.87	cu in.
pt (liquid)	0.125	gal (liquid)
pt (liquid)	0.4732	L
poise	1.0	g/cm-sec
pdl	1.3826×10^4	dyn
pdl	0.0141	kg
pdl	0.03108	lb
	Q	
quadrant (angle)	5400	min
quadrant (angle)	1.571	radian
qt (dry)	67.2	cu in.
qt (liquid)	946.4	cu cm
qt (liquid)	0.03342	cf
qt (liquid)	57.75	cu in.
qt (liquid)	0.9463	L

To Convert	Multiply By	To Obtain
	R	
radian	57.3	degree
radian	3438	min
radian	0.6366	quadrant
radian/sec	57.3	degree/sec
radian/sec	9.549	rpm
radian/sec	0.1592	rps
radian/sec/sec	0.1592	rev/sec/sec
ream	500.0	sheet
rev	360.0	degree
rev	4.0	quadrant
rev	6.283	radian
rev/min	6.0	degree/sec
rev/min	0.1047	radian/sec
rev/min	0.01667	rev/sec
rev/min/min	0.001745	radian/sec/sec
rev/min/min	2.778×10^{-4}	rev/sec/sec
rev/sec	360.0	degree/sec
rev/sec	6.283	radian/sec
rev/sec	60.0	rev/min
rev/sec/sec	6.283	radian/sec/sec
rev/sec/sec	3600	rev/min/min
rod	5.029	m
rod	5.5	yd
rod	16.5	ft
	S	
second (angle)	0.01667	min
second (angle)	4.848×10^{-6}	radian
slug	14.59	kg

To Convert	Multiply By	To Obtain
slug	32.17	lb
sphere (solid angle)	12.57	steradian
sq cm	0.001076	sq ft
sq cm	0.1550	sq in.
sq cm	1.0×10^{-4}	sq m
sq cm	100.0	sq mm
sq ft	2.296×10^{-5}	acre
sq ft	929.0	sq cm
sq ft	144.0	sq in.
sq ft	0.0929	sq m
sq ft	0.1111	sq yd
sq in.	6.452	sq cm
sq in.	0.006944	sq ft
sq in.	645.2	sq mm
sq in.	7.716×10^{-4}	sq yd
sq km	247.1	acre
sq km	1.076×10^{7}	sq ft
sq km	1.0×10^{6}	sq m
sq km	0.3861	sq mile
sq km	1.196×10^{6}	sq yd
sq m	2.471×10^{4}	acre
sq m	10.76	sq ft
sq m	3.861×10^{-7}	sq mile
sq m	1.196	sq yd
sq mile	640.0	acre
sq mile	2.788×10^{7}	sq ft
sq mile	2.590	sq km
sq mile	2.590×10^{6}	sq m
sq mile	3.098×10^{6}	sq yd
sq mm	0.01	sq cm

To Convert	Multiply By	To Obtain
	S	
sq mm	1.076×10^{-5}	sq ft
sq mm	0.00155	sq in.
sq yd	2.066×10^{-4}	acres
sq yd	8361	sq cm
sq yd	9.0	sq ft
sq yd	1296	sq in.
sq yd	0.8361	sq m
sq yd	3.228×10^{-7}	sq mile
steradian	0.07958	sphere
steradian	0.1592	hemisphere
steres	1000	L
steres	1.0	cu m
	T	
temp (° C + 273)	1.0	abs. temp (K)
temp (° C + 17.78)	1.8	temp (° F)
temp (° F + 460)	1.0	abs. temp (° R)
temp (° F - 32)	0.5555	temp (° C)
ton (long)	1016	kg
ton (long)	2240	lb
ton (metric)	1000	kg
ton (metric)	2205	lb
ton (short)	907.2	kg
ton (short)	2000	lb
ton (short)/sq ft	9765	kg/sq m
ton (short)/sq ft	13.89	lb/sq in.
ton of water/24 hr	0.1664	gal/min
ton of water/24 hr	1.3349	cf/hr

To Convert	Multiply By	To Obtain
	W	
watt	3.4129	btu/hr
watt	0.0569	btu/min
watt	1.0×10^{7}	erg/sec
watt	44.27	ft-lb/min
watt	0.7378	ft-lb/sec
watt	0.00134	hp
watt	0.00136	hp (metric)
watt	0.01433	kg-cal/min
watt	0.001	kW
watt (abs.)	1.0	J/sec
watt-hr	3.413	btu
watt-hr	3.6×10^{10}	erg
watt-hr	2656	ft-lb
watt-hr	860.5	g-cal
watt-hr	0.00134	hp-hr
watt-hr	0.8605	kg-cal
watt-hr	367.2	kg-m
watt-hr	0.001	kW-hr
watt (international)	1.000165	watt (absolute)
week	168.0	hr
week	10,080	min
	Y	
yd	91.44	cm
yd	9.144×10^{-4}	km
yd	0.9144	m
yd	5.682×10^{-4}	mile (statute)
yd	914.4	mm
year	365.26	day (mean solar)

Steel Pipe Flanges* (Dimensions)

Class 150

Nom. Pipe Size	OD of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
2	6.00	0.75	4.75	0.75	4	5/8
2-1/2	7.00	0.88	5.50	0.75	4	5/8
3	7.50	0.94	6.00	0.75	4	5/8
4	9.00	0.94	7.50	0.75	8	5/8
6	11.00	1.00	9.50	0.88	8	3/4
8	13.50	1.12	11.75	0.88	8	3/4
10	16.00	1.19	14.25	1.00	12	7/8
12	19.00	1.25	17.00	1.00	12	7/8
14	21.00	1.38	18.75	1.12	12	1
16	23.50	1.44	21.25	1.12	16	1
18	25.00	1.56	22.75	1.25	16	1-1/8
20	27.50	1.69	25.00	1.25	20	1-1/8
22	29.50	1.81	27.25	1.38	20	1-1/4
24	32.00	1.88	29.50	1.38	20	1-1/4
26	34.25	2.69	31.75	1.38	24	1-1/4
28	36.50	2.81	34.00	1.38	28	1-1/4
30	38.75	2.94	36.00	1.38	28	1-1/4
32	41.75	3.18	38.50	1.62	28	1-1/2
34	43.75	3.25	40.50	1.62	32	1-1/2
36	46.00	3.56	42.75	1.62	32	1-1/2
38	48.75	3.44	45.25	1.62	32	1-1/2
40	50.75	3.56	47.25	1.62	36	1-1/2
42	53.00	3.81	49.50	1.62	36	1-1/2
44	55.25	4.00	51.75	1.62	40	1-1/2
46	57.25	4.06	53.75	1.62	40	1-1/2
48	59.50	4.25	56.00	1.62	44	1-1/2
50	61.75	4.38	58.25	1.88	44	1-3/4
52	64.00	4.56	60.50	1.88	44	1-3/4
54	66.25	4.75	62.75	1.88	44	1-3/4
56	68.75	4.88	65.00	1.88	48	1-3/4
58	71.00	5.06	67.25	1.88	48	1-3/4
60	73.00	5.19	69.25	1.88	52	1-3/4

* Size 2" through 24" (except 22") are in accordance with ASME B16.5.
Size 22" and sizes 26" and larger are per MSS SP-44.

Steel Pipe Flanges*
(Dimensions)

Class 300

Nom. Pipe Size	OD of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
2	6.50	0.88	5.00	0.75	8	5/8
2-1/2	7.50	1.00	5.88	0.88	8	3/4
3	8.25	1.12	6.62	0.88	8	3/4
4	10.00	1.25	7.88	0.88	8	3/4
6	12.50	1.44	10.62	0.88	12	3/4
8	15.00	1.62	13.00	1.00	12	7/8
10	17.50	1.88	15.25	1.12	16	1
12	20.50	2.00	17.75	1.25	16	1-1/8
14	23.00	2.12	20.25	1.25	20	1-1/8
16	25.50	2.25	22.50	1.38	20	1-1/4
18	28.00	2.38	24.75	1.38	24	1-1/4
20	30.50	2.50	27.00	1.38	24	1-1/4
22	33.00	2.62	29.25	1.62	24	1-1/2
24	36.00	2.75	32.00	1.62	24	1-1/2
26	38.25	3.12	34.50	1.75	28	1-5/8
28	40.75	3.38	37.00	1.75	28	1-5/8
30	43.00	3.62	39.25	1.88	28	1-3/4
32	45.25	3.88	41.50	2.00	28	1-7/8
34	47.50	4.00	43.50	2.00	28	1-7/8
36	50.00	4.12	46.00	2.12	32	2
38	46.00	4.25	43.00	1.62	32	1-1/2
40	48.75	4.50	45.50	1.75	32	1-5/8
42	50.75	4.69	47.50	1.75	32	1-5/8
44	53.25	4.88	49.75	1.88	32	1-3/4
46	55.75	5.06	52.00	2.00	28	1-7/8
48	57.75	5.25	54.00	2.00	32	1-7/8
50	60.25	5.50	56.25	2.12	32	2
52	62.25	5.69	58.25	2.12	32	2
54	65.25	6.00	61.00	2.38	28	2-1/4
56	67.25	6.06	63.00	2.38	28	2-1/4
58	69.25	6.25	65.00	2.38	32	2-1/4
60	71.25	6.44	67.00	2.38	32	2-1/4

* Size 2″ through 24″ (except 22″) are in accordance with ASME B16.5.
Size 22″ and sizes 26″ and larger are per MSS SP-44.

Steel Pipe Flanges*
(Dimensions)

Class 400

Nom. Pipe Size	OD of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
2						
2-1/2		Use Class 600 dimensions in these sizes.				
3						
4	10.00	1.38	7.88	1.00	8	7/8
6	12.50	1.62	10.62	1.00	12	7/8
8	15.00	1.88	13.00	1.12	12	1
10	17.50	2.12	15.25	1.25	16	1-1/8
12	20.50	2.25	17.25	1.38	16	1-1/4
14	23.00	2.38	20.25	1.38	20	1-1/4
16	25.50	2.50	22.50	1.50	20	1-3/8
18	28.00	2.62	24.75	1.50	24	1-3/8
20	30.50	2.75	27.00	1.62	24	1-1/2
22	33.00	2.88	29.25	1.75	24	1-5/8
24	36.00	3.00	32.00	1.88	24	1-3/4
26	38.25	3.50	34.50	1.88	28	1-3/4
28	40.75	3.75	37.00	2.00	28	1-7/8
30	43.00	4.00	39.25	2.12	28	2
32	45.25	4.25	41.50	2.12	28	2
34	47.50	4.38	43.50	2.12	28	2
36	50.00	4.50	46.00	2.12	32	2
38	47.50	4.88	44.00	1.88	32	1-3/4
40	50.00	5.12	46.25	2.00	32	1-7/8
42	52.00	5.25	48.25	2.00	32	1-7/8
44	54.50	5.50	50.50	2.12	32	2
46	56.75	5.75	52.75	2.12	36	2
48	59.50	6.00	55.25	2.38	28	2-1/4
50	61.75	6.19	57.50	2.38	32	2-1/4
52	63.75	6.38	59.50	2.38	32	2-1/4
54	67.00	6.69	62.25	2.62	28	2-1/2
56	69.00	6.88	64.25	2.62	32	2-1/2
58	71.00	7.00	66.25	2.62	32	2-1/2
60	74.25	7.31	69.00	2.88	32	2-3/4

* Size 2″ through 24″ (except 22″) are in accordance with ASME B16.5.
Size 22″ and sizes 26″ and larger are per MSS SP-44.

Steel Pipe Flanges*
(Dimensions)

Class 600

Nom. Pipe Size	OD of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
2	6.50	1.00	5.00	0.75	8	5/8
2-1/2	7.50	1.12	5.88	0.88	8	3/4
3	8.25	1.25	6.62	0.88	8	3/4
4	10.75	1.50	8.50	1.00	8	7/8
6	14.00	1.88	11.50	1.12	12	1
8	16.50	2.19	13.75	1.25	12	1-1/8
10	20.00	2.50	17.00	1.38	16	1-1/4
12	22.00	2.62	19.25	1.38	20	1-1/4
14	23.75	2.75	20.75	1.50	20	1-3/8
16	27.00	3.00	23.75	1.62	20	1-1/2
18	29.25	3.25	25.75	1.75	20	1-5/8
20	32.00	3.50	28.50	1.75	24	1-5/8
22	34.25	3.75	30.62	1.88	24	1-3/4
24	37.00	4.00	33.00	2.00	24	1-7/8
26	40.00	4.25	36.00	2.00	28	1-7/8
28	42.25	4.38	38.00	2.12	28	2
30	44.50	4.50	40.25	2.12	28	2
32	47.00	4.62	42.50	2.38	28	2-1/4
34	49.00	4.75	44.50	2.38	28	2-1/4
36	51.75	4.88	47.00	2.62	28	2-1/2
38	50.00	6.00	45.75	2.38	28	2-1/4
40	52.00	6.25	47.75	2.38	32	2-1/4
42	55.25	6.62	50.50	2.62	28	2-1/2
44	57.25	6.81	52.50	2.62	32	2-1/2
46	59.50	7.06	54.75	2.62	32	2-1/2
48	62.75	7.44	57.50	2.88	32	2-3/4
50	65.75	7.75	60.00	3.12	28	3
52	67.75	8.00	62.00	3.12	32	3
54	70.00	8.25	64.25	3.12	32	3
56	73.00	8.56	66.75	3.38	32	3-1/4
58	75.00	8.75	68.75	3.38	32	3-1/4
60	78.50	9.19	71.15	3.62	28	3-1/2

* Size 2″ through 24″ (except 22″) are in accordance with ASME B16.5.
Size 22″ and sizes 26″ and larger are per MSS SP-44.

Steel Pipe Flanges*
(Dimensions)

Class 900

Nom. Pipe Size	OD of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
2 2-1/2	Use Class 1500 dimensions in these sizes.					
3	9.50	1.50	7.50	1.00	8	7/8
4	11.50	1.75	9.25	1.25	8	1-1/8
6	15.00	2.19	12.50	1.25	12	1-1/8
8	18.50	2.50	15.50	1.50	12	1-3/8
10	21.50	2.75	18.50	1.50	16	1-3/8
12	24.00	3.12	21.00	1.50	20	1-3/8
14	25.25	3.38	22.00	1.62	20	1-1/2
16	27.75	3.50	24.25	1.75	20	1-5/8
18	31.00	4.00	27.00	2.00	20	1-7/8
20	33.75	4.25	29.50	2.12	20	2
24	41.00	5.50	35.50	2.62	20	2-1/2
26	42.75	5.50	37.50	2.88	20	2-3/4
28	46.00	5.62	40.25	3.12	20	3
30	48.50	5.88	42.75	3.12	20	3
32	51.75	6.25	45.50	3.38	20	3-1/4
34	55.00	6.50	48.25	3.62	20	3-1/2
36	57.50	6.75	50.75	3.62	20	3-1/2
38	57.50	7.50	50.75	3.62	20	3-1/2
40	59.50	7.75	52.75	3.62	24	3-1/2
42	61.50	8.12	54.75	3.62	24	3-1/2
44	64.88	8.44	57.62	3.88	24	3-3/4
46	68.25	8.88	60.50	4.12	24	4
48	70.25	9.19	62.50	4.12	24	4

* Size 2″ through 24″ (except 22″) are in accordance with ASME B16.5.
Size 22″ and sizes 26″ and larger are per MSS SP-44.

Steel Pipe Flanges*
(Dimensions)

Class 1500

Nom. Pipe Size	OD of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
1/2	4.75	0.88	3.25	0.88	4	3/4
3/4	5.12	1.00	3.50	0.88	4	3/4
1	5.88	1.12	4.00	1.00	4	7/8
1-1/4	6.25	1.12	4.38	1.00	4	7/8
1-1/2	7.00	1.25	4.88	1.12	4	1
2	8.50	1.50	6.50	1.00	8	7/8
2-1/2	9.62	1.62	7.50	1.12	8	1
3	10.50	1.88	8.00	1.25	8	1-1/8
4	12.25	2.12	9.50	1.38	8	1-1/4
6	15.50	3.25	12.50	1.50	12	1-3/8
8	19.00	3.62	15.50	1.75	12	1-5/8
10	23.00	4.25	19.00	2.00	12	1-7/8
12	26.50	4.88	22.50	2.12	16	2
14	29.50	5.25	25.00	2.38	16	2-1/4
16	32.50	5.75	27.75	2.62	16	2-1/2
18	36.00	6.38	30.50	2.88	16	2-3/4
20	38.75	7.00	32.75	3.12	16	3
24	46.00	8.00	39.00	3.62	16	3-1/2

* Dimensions are in accordance with ASME B16.5.

Steel Pipe Flanges*
(Dimensions)

Class 2500

Nom. Pipe Size	OD of Flange	Thick. of Flange	Bolt Circle Diam.	Bolt Hole Diam.	No. of Bolts	Diam. of Bolts
1/2	5.25	1.19	3.50	0.88	4	3/4
3/4	5.50	1.25	3.75	0.88	4	3/4
1	6.25	1.38	4.25	1.00	4	7/8
1-1/4	7.25	1.50	5.12	1.12	4	1
1-1/2	8.00	1.75	5.75	1.25	4	1-1/8
2	9.25	2.00	6.75	1.12	8	1
2-1/2	10.50	2.25	7.75	1.25	8	1-1/8
3	12.00	2.62	9.00	1.38	8	1-1/4
4	14.00	3.00	10.75	1.62	8	1-1/2
6	19.00	4.25	14.50	2.12	8	2
8	21.75	5.00	17.25	2.12	12	2
10	26.50	6.50	21.25	2.62	12	2-1/2
12	30.00	7.25	24.38	2.88	12	2-3/4

* Dimensions are in accordance with ASME B16.5.

Specific Gravity of Gases Relative to Air

Name of Gas	Chemical Formula	Specific Gravity
Acetylene	C_2H_2	0 .9107
Air		1.0000
Ammonia	NH_3	0 .5961
Anthracite Producer Gas		0 .85
Argon	Ar	1 .377
Benzene	C_6H_6	2 .6920
Bituminous Producer Gas		0 .86
Blast Furnace Gas		1 .00
Blue Water Gas		0 .53
Butane	C_4H_{10}	2 .06654
Butylene	C_4H_8	1 .9936
Carbon Dioxide	CO_2	1 .5282
Carbon Monoxide	CO	0 .9672
Carburated Water Gas		0 .65
Coke Oven Gas		0 .42
Ethane	C_2H_6	1 .04882
Ethylene	C_2H_4	0 .974
Helium	He	0 .138
Hydrochloric Acid	HCl	1 .256
Hydrogen	H_2	0 .06959
Methane	CH_4	0 .5543
Methyl Chloride	CH_3Cl	1 .738
Natural Gas, Cleveland		0 .65
Natural Gas, Oil City, Pa.		0 .71
Nitrogen	N_2	0 .9718
Nitric Oxide	NO	1 .034
Nitrous Oxide	N_2O	1 .518
Oxygen	O_2	1 .1053
Pentane	C_5H_{12}	2 .4872
Propane	C_3H_8	1 .5617
Propylene	C_3H_6	1 .4504
Sulfur Dioxide	SO_2	2 .264
Toluene	C_7H_8	3 .1760
Xylene	C_8H_{10}	3 .6618

Specific Gravity of Liquids

Liquid	Specific Gravity at 60° F Referred to Water at 60° F
Acetone	0.792
Alcohol, Ethyl (100%)	0.789
Alcohol, Methyl (100%)	0.796
Acid, Muriatic (40%)	1.20
Acid, Nitric (91%)	1.50
Acid, Sulfuric (87%)	1.80
Bunkers C Fuel Max.	1.014
Distillate	0.850
Fuel 3 Max.	0.898
Fuel 5 Min.	0.966
Fuel 5 Max.	0.993
Fuel 6 Min.	0.993
Gasoline	0.751
Gasoline, Natural	0.680
Kerosene	0.815
M.C. Residuum	0.935
Mercury	13.570
Olive Oil	0.919
Pentane	0.624
SAE 10 Lube *	0.876
SAE 30 Lube *	0.898
SAE 70 Lube *	0.916
Salt Creek Crude	0.843
Sea Water	1.025
32.6° API Crude	0.862
35.6° API Crude	0.847
40° API Crude	0.825
48° API Crude	0.788
Water	1.000

* 100 Viscosity Index

Other Useful Information

Gas Constants (R)

R = 0.0821	(atm) (L)/(g-mol) (K)
R = 1.987	g-cal/(g-mol) (K)
R = 1.987	btu/(lb-mol) (° R)
R = 1.987	chu/(lb-mol) (K)
R = 8.314	J/(gm-mol) (K)
R = 1546	(ft) (lb-force)/(lb-mol) (° R)
R = 10.73	(lb-force/sq in.) (cf)/(lb-mol) (° R)
R = 18,510	(lb-force/sq in.) (cu in.)/(lb-mol) (° R)
R = 0.7302	(atm) (cf)/(lb/mol) (° R)
R = 8.48 x 10^5	(Kg/m^2) (cu cm)/(lb-mol) (K)

Acceleration of Gravity (Standard)

g = 31.17 ft/sec^2 = 980.6 cm/sec^2

Velocity of Sound in Dry Air 32° F (0° C) and 1 atm

33,136 cm/sec = 1089 ft/sec

lb/hr of gas x 13.3/spec. grav. = standard cf/hr

Velocity (ft/sec) = .408 x Q/d^2

Where Q = flow rate in cf/sec

and d = inside pipe diam. in ft

Viscosity Conversion

$$C.S. = \frac{C.P.}{S.G.}$$

C.P. = S.G. x C.S.

Where

C.S. = Centistoke

C.P. = Centipoise

S.G. = Specific Gravity

CAMERON

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and location information go to:
www.c-a-m.com/valves

HSE Policy Statement
At Cameron, we are committed ethically, financially and personally to a working environment where no one gets hurt and nothing gets harmed.