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TECHNICAL HANDBOOK

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Section 1: Basics of Valves

1. Brief History of Valves

Prior to Greek and Roman times, little is known about the methods used to control the flow of fluids. Some forms of sluice gate was obviously used to hold and retain water in irrigation channels, and we know there was some knowledge of the principles of flow because of the water clocks made by the early Egyptians.

The Greek and Roman periods saw the development of many mechanical and hydraulic machines and the first use of valves of sophisticated design. In the case of the plug cock valve, the design remained virtually unchanged until the 19th century.

Flap valves and coin valves were the forebears of the present swing and lift check valves and were used in the water force pumps. Bronze and brass plug cocks were in common use as stop valves on water mains and supply pipes to public and domestic buildings during the Roman period. A major innovation was the introduction of the groove-packed plug cock in 1875. This made the valve easier to operate and more suitable for use with steam.

The parallel slide valve was introduced in 1886, in which the sealing of the valve was effected by the line pressure on the disc - a development which is still being manufactured today.

During the past 60 years, many other types of valves have been designed to cater to the new and hazardous processes which have been developed.

Traditional valve types such as gate and globe valves have been reappraised as improvements have taken place in materials. This has also lead to the development of the lubricated taper plug, ball, butterfly and diaphragm valves which have all been developed and engineered into practical and industrially acceptable products.

The lubricated taper plug valve was developed during World War I by Sven Nordstrom, a Swedish engineer, who was trying to overcome the excessive leakage and sticking of ordinary plug valves.

The diaphragm valve was developed by a South African engineer (named Saunders) who, working in the gold mines, was faced with excessive leakage of compressed air at the glands of the valves being used. In 1929 he developed a valve using a diaphragm both to isolate the valve operating mechanism and also to act as the closing member, which proved to be a great success.

The ball, or spherical plug valve, is a newcomer to the valve family. Initially developed for fuel system on aircraft during World War II, the valve was further developed in the post-war years to produce the first industrial range of ball valves. During the last 30 years, many valve manufacturers have directed their attention to the ball valve and a variety of new, improved designs have been introduced. This has led to a much wider diversification and expansion of the capabilities of the ball valve in practically all sections of the valve market.

History records James Watt who made use of a butterfly valve in his steam engine, and the first Mercedes car built around 1901 introduced a butterfly valve in the fuel intake linked to the accelerator pedal. The first butterfly valves used metal-to-metal seats, but, after World war II, improvements in modern synthetic rubbers for the sealing members extended the application of the butterfly valve into many industrial fields. In the last ten years, the butterfly valve has been developed further to handle much higher pressures and temperatures than previously envisaged.

2. Type of Valves

Valve is a piping component which influences the fluid flow in systems comprising of pipes, vessels, apparatus, and machines by opening, closing, diverting, mixing, or partially obstructing the passage through itself.

There are five basic designs of valves, distinguished by the operating motion of their closure device (obturator) and the direction of flow in the seating area. The valve types are illustrated in Fig. 1.

(1) *Gate valve:* A valve in which the closure device moves in a straight line and, in the seating area, across (at right angles to) the direction of flow.

(2) *Globe valve:* A valve in which the closure device moves in a straight line and, in the seating area, longitudinally (parallel) to the direction of flow.

(3) *Plug and Ball valves:* in which the closure device rotates about an axis at right angles to the direction of flow and, in the open position the flow passes through it.

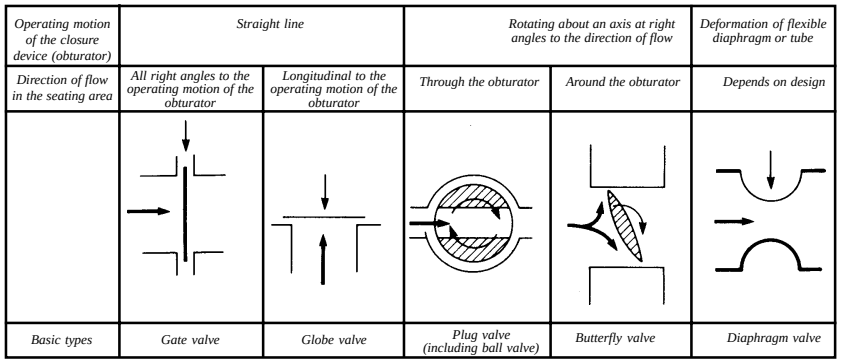
(4) *Butterfly valve:* A valve in which the closure device rotates about an axis at right angles to the direction of flow and, in the open position, the flow passes around it.

(5) *Diaphragm valve:* A valve in which the closure device is provided by the deformation of a flexible diaphragm or tube. The valves most commonly used throughout industry can be generally categorized as linear (multi-turn) or rotary (quarter-turn) as listed in Table 1.

A major feature of the linear valve is that tighter shut-off within the limits of the materials and designs may be achieved by tightening down on the threaded stem. Rotary valves, on the other hand, are usually simple, lightweight, easy to automate, and easy to maintain; they are available in multiport configurations, are quick opening, and can be adapted to a broad range of applications.

Table 1

Linear valves	*Rotary valves*
Gate	Ball
Globe	Plug
Diaphragm	Butterfly



The types of valves related to their function are as follows

(1) *Isolating valve:* A valve designed for use in the fully open or fully closed position.

(2) *Regulating valve:* A valve designed for use in all positions between fully open and fully closed.

(3) *Control valve:* A power operated device which changes the fluid flow rate in a process control system. It consists of a valve connected to an actuator that is capable of changing the position of the closure device in the valve in response to a signal from the controlling system.

(4) *Safety relief valve:* A valve which automatically, without the assistance of any energy other than that of the fluid concerned, discharges a certified quantity of the fluid so as to prevent a predetermined safe pressure being exceeded, and is designed to re-close and prevent the further flow of fluid after normal pressure conditions of service have been restored.

(5) *Check (non-return) valve:* A valve which automatically opens by fluid flow in a defined direction and automatically closes by fluid flow in the reverse direction.

3. Valve Terminology

The definitions are not intended to be in conflict with definitions as used in common codes and standards, but rather are intended to acquaint the reader with the nomenclature as commonly used in conversation and general written correspondence about valves.

AISI: American Iron and Steel Institute- organization that developed the numbering system for steels, commonly applied to rolled or wrought products.

ANSI: American National Standards Institute- standards organization responsible for coordinating the work of U.S. standards writing groups with each other and with other national standards organizations. Known as ASA until 1967.

Antistatic: A feature incorporated in valves to ensure no static build up and hence prevent spark ignition in an inflammable media.

API: American Petroleum Institute-organization that develops standards for material and articles used in the petroleum and gas-gathering (production) industry, and also the hydrocarbon-processing industry.

ASME: American Society of Mechanical Engineers-organization responsible for maintaining several codes and large numbers of standards, covering numerous different industries.

ASTM: American Society for Testing and Materials-organization responsible for maintaining standards covering materials, testing methods, and in some cases such as plastics, the dimensional and manufacturing standards for finished products.

Backseat: In gate valves, this is the seating surface at the top of the body cavity, which a shoulder on the stem seats against to prevent leakage through the packing area.

Bar: Unit of pressure equal to 14.5 psi or 100 kPa.

Bolted bonnet: A valve construction in which the primary closure (bonnet or cap or cover) is retained by bolts that resist the internal pressure forces.

Block and bleed: A valve configuration in which the flow through the valve, from the inlet port to the outlet port, is blocked, while another small port is provided for the

purpose of bleeding down (draining or depressuring) the cavity in between. Sometimes a single valve so equipped, sometimes an assembly of two or three valves.

Blowdown: In boiler terminology, the practice of discharging from the boiler small quantities of water from regions rich in dissolved or suspended solids, in order to keep the solids from concentrating in the boiler water and fouling the inside surfaces of the boiler. Also, in safety relief valves, refers to the discharge of fluid through the valve when it opens.

Body: The part of a valve that encloses the internals and to which the topworks are attached. Normally the end connections are an integral part of the body.

Bonnet: The cover or removable top component of a valve, containing the packing gland and stem opening. Generally gate and globe valves are considered to have a bonnet. The same part on other valves is called the cover or cap.

BSI: British Standards Institution-organization responsible for standards in Great Britain and Northern Ireland.

Bubble-tight: A seat leakage condition in which, during the allotted time of the test, no perceptible leakage comes past the seat being tested. Applies to air-under-water testing-the same test using water- under-air is referred to as drop tight. Defined in API 598, MSS-SP-61, and ANSI B16.104.

Buna-N: Common term for nitrile rubber. One trade name is Hycar (trademark of Goodrich Chemical Co.)

Butt weld: Weld where the adjoining edges to be welded are parallel and facing each other. The weld preparation for a butt weld can be a single-or double- angle bevel, a J-bevel or U-bevel or parallel without bevel for very thin welds.

Bypass: A smaller line containing a valve that comes off of a larger line just upstream of a major valve and rejoins the same line just downstream of the valve. The line provides a way to bypass the main valve.

Cavitation: The phenomenon in which the local pressure at a point in a flowing fluid becomes lower than the vapor pressure of the fluid, thus causing small bubbles to form. The bubbles then implode when the local pressure rises again, causing shock waves that are very destructive to the walls of the passageway or the valve trim in the area of the cavitation.

Cavity Pressure: It is the pressure build up within the combined cavity of closure member and valve body. It may lead to *thermopiezo effect.* (See for details under this heading)

Closure: The device or object that is placed into or across an opening in a pressure-retaining body for the purpose of closing it off.

Control valve: Valve that has an automatic actuator that responds to signals sent by pneumatic, electrical, or other means for the purpose of controlling or varying the fluid flow in the pipe line. In common usage, any valve equipped with an actuator.

Cryogenic: Referring to temperatures significantly below normal atmospheric temperatures. Definitions vary, but often any temperature below - 50°F (-45°C) is considered cryogenic.

CWP: Cold working pressure-a pressure rating that indicates the maximum allowable pressure under nonshock (steady-state), ambient-temperature conditions.

Design pressure: The pressure used in calculating required wall thicknesses, operating torques, flange ratings, and other variables. Design temperature: The temperature that is used to determine allowable stresses for the purpose of design calculations.

DIN: Deutsche Industrie Norme-West German national standards organization.

Double block and bleed: Either a pair of block valves with a section of piping between them that contains a bleed point, or a single valve that seals in two locations with a bleed point between the two. The bleed may or may not be valved itself, and may be normally open or normally closed.

Elastomer: A polymer or long molecular chain material having significant elastic properties.

End to end: The dimensions from one end to the opposite end of a valve. Usually used to refer to valves that do not have flange faces.

EPDM: Ethylenepropylene dimonomer-the generic name for an elastomer made from ethylene and propylene. One trade name is Nordel.

Explosion-proof: A degree of protection of electrical components in which the component can be installed in an explosive atmosphere, one where the stoichiometric ratio of flammable vapor to air is such that an explosion could occur, with the area where arcing takes place being effectively isolated from the atmosphere.

Face-to-face: The dimension of a flanged valve, from the mating surface (raised face or flat face) of one end flange to the same surface on the opposite end flange. Valves with ring-joint flanges are dimensioned from the outermost surfaces, although that is not the mating surface.

Fail-closed: A condition in which a valve or other component that is normally in some position, open, closed, or in between, will close if power or signal is lost.

Fail-last: Also **fail-locked** and **stayput** - a condition in which a valve or other component that is normally in some position, open, closed, or in between, will freeze in its last position if power or signal is lost. Generally less desirable than either fail-closed or fail-open.

Fail-open: A condition in which a valve or other component that is normally in some position, open, closed, or in between, will open if power or signal is lost.

Fail-safe: A design for equipment or valves such that, if a failure or loss of power occurs, the item will position itself in a configuration that limits further damage to itself, other equipment, or nearby personnel.

Female thread: A recessed threaded connection with internal threads.

FF: Flat face-a flange surface in which the gasket sealing area is the entire surface from the inside diameter to the outside edge of the flange. The surface is flat, normally smooth without serrations.

Fire resistant: Term referring to an item that has been designed to survive, at least for a while, under normal fire conditions in a plant. May be either intrinsically resistant to fire damage, designed with fire-resistant backup systems such as fire-safe, soft- seated valves,

or externally protected with insulation or intumescent (charring) materials.

Fire-safe: A valve design that is capable of passing a fire test, with specified limits on leakage to the atmosphere and downstream after being closed subsequent to the fire exposure. Several fire test specifications are in common use. Also said of enclosures built around valve actuators and supply lines or cable trays leading to such valves, more properly referred to as fire resistant.

Flange: A pipe fitting or a portion of a flanged piping component, designed to be mated to a companion flange or flanged surface by means of bolts inserted through holes in the flange face.

Full bore or full port: A valve or other component in which the seat area has substantially the same cross section and cross-sectional area as the end connections have. Depending on what the valve will be used for, sometimes having the same area is sufficient, but sometimes the same internal diameter all the way around is required.

Galling: A physical phenomenon wherein two mating or closely pressed surfaces, such as the threaded surfaces of a nut and a bolt, momentarily bond or weld together in microscopically small areas, then are torn apart. The resultant surfaces are very rough and damaged.

Galvanic corrosion: Corrosion that occurs where dissimilar metals are in close proximity in an electrolytic solution, such as water. The anode side is the one that loses metal (is less noble).

Gasket: A component whose purpose is to seal a joint between two larger components, softer than the surfaces of the joint being sealed, and usually squeezed by means of bolting or clamping to effect a seal.

Grafoil: Trademark of Union Carbide Corp. for a flexible graphite foil used for making gaskets and packing.

Hardfaced or hardfacing: Treatment that results in a region on the surface of a part that is harder than the interior or substrate. Normally done by weld deposition of a harder alloy such as Stellite (trademark of Stoody Deloro Stellite Inc.)

Header: A large line from which smaller lines branch out.

Hydrostatic test: A pressure test using water, in which the item or system to be tested is filled with water and pressurized, using a pump, to some pressure, to detect leaks. Often the pressure used is times the design pressure, plus a factor to correct for lower allowable stresses at operating temperature, plus water head.

Hypalon Trademark of E.I. du Font de Nemours Co. Inc. for a polyethylene-based rubber.

ID: Inside diameter-the distance, either nominal or actual, from the inside wall of an annular surface to the opposite inside wall.

Intergranular corrosion: Corrosion that occurs in the boundaries between grains. The surface will have an “etched” or “crazed” appearance.

ISO: International Standards Organization- worldwide standards coordinating organization.

Limit switch: Electromechanical device that detects the arrival of an object such as a

valve stem indicator at a predetermined point, by means of the detected object touching a movable part of the limit switch and making or breaking a circuit. The presence/ absence of this current constitutes a signal that is in turn detected by some other device and causes some other action to happen, such as turning off a drive motor. A **proximity switch** performs the same function but is an electromagnetic device.

Male thread: An external or projecting thread, for instance on the end of a pipe.

MAWP: Maximum allowable working pressure-the maximum pressure (must be stated in conjunction with a temperature) that a component can be subjected to on a continuous basis. Could be greater 24 that the design pressure, since the MAWP is determined by the actual installed thickness on as- built condition of the component.

Metal to metal: A seating design characterized by the lack of any soft deformable seating material. Metal-to-metal seats can withstand much higher pressures and temperatures than soft seats, but leakage rates are usually greater except in special valve designs.

MSS: Manufacturers standardization Society of the Valve and Fitting Industry-trade organization responsible for issuing voluntary standards for valves and piping material. MSS withdraws its standards when another standards-issuing body such as ASME issues one covering the same subject.

MPT: Magnetic particle test or magnetic particle inspection - an examination technique using magnetic fields or an electromagnetic technique to pass a magnetic field through a magnetizable steel to detect flaws. Location of flaws is made visible by sprinkling iron filings over the surface of the part, which tend to move to the location of defects that interrupt the magnetic force lines, including defects that lie up to 1/16 in. (2mm) or so under the surface. Defined in ASTM-E709.

NACE: National Association of Corrosion Engineers-organization responsible for publishing recommended practices and data on corrosion and corrosion resistance.

NDE: Non destructive examination-general term for any examination or inspection performed on materials that does not involve destroying the item being tested.

Nitrite: A type of synthetic rubber. One trade name is Hycar.

Nominal size: Anything, such as pipe, that is designated by a dimension less number and not a size in units of measure such as inches or millimeters.

NPT: National Pipe Thread-standard tapered thread for pressure pipe.

OD: Outside diameter-actual diameter of a part or a pipe, measure to the outside surface. In pipe, the outside diameter is its specified diameter in actual units. For instance, NPS 2 (or “2-in.”) pipe is 2.375- in. (60.3mm) nominal outside diameter.

Operating pressure: The pressure that a component normally sees during the course of day- to-day operation.

Operating temperature: The temperature that a component normally sees during day-to-day operation.

OS&Y: Outside screw and yoke-valve design in which the stem threads are above the packing gland, or outside the valve body, and there is a yoke or bracket to support the top or outer end of the stem.

Packing: Any soft substance used to seal the area of a shaft where it protrudes from inside a pressure boundary, such as a valve or pump.

P&ID: Piping and instrument diagram-generally, the drawing that shows schematically all the equipment, piping, instrumentation, and control devices in a plant, but without showing geographic locations or orientation. Pascal’s Law: A pressure applied at any point in a liquid at rest is transmitted equally and undiminished in all directions to every other point in the liquid.

PEEK: Polyetheretherketone-high-temperature semirigid elastomer, developed by ICI and trademarked Victrex.

Phosphatizing: A surface treatment of steel parts consisting of a dip into an acid phosphate bath that intimately coats the surface with a phosphate-rich layer that retards rusting and provides better coating adhesion.

Pig: Also known as a **scraper**-the object placed in a pipe line, to be pushed along by line pressure, for the purpose of separating one fluid from a different one being shipped through the same line or to clean (scrape) the walls of the pipe.

Pitting corrosion: Corrosion characterized by small cavities or pits in the metal surface, which may combine to form large pits.

PN: Nominal pressure-standard abbreviation for pressure rating used in ISO standards.

Pressure relieving: It is the process of relieving the built up cavity pressure by providing some means for pressure to escape.

PSIG: Pounds per square inch, gage-pressure force expressed with reference to standard atmospheric pressure. Standard atmospheric pressure is defined as 14.7 psig.

PT: Penetrant test or dye penetrant test or dye penetrant inspection-an examination technique that uses a penetrating dye sprayed on the surface of a part, followed by a developer that washes off the dye from all areas except pits, cracks, and other surface defects. The dye is either bright red or fluorescent, and examination is done either under room light or ultraviolet light. This test works on all nonporous surfaces but an detect surface artifacts only. Defined in ASTM-E165.

Resilient seat: Any seating configuration that includes a soft, resilient seating element, either on the fixed seat or on the closure element but not usually both.

RF: Raised face- a flanged sealing surface in which the gasket seating area is a portion of the diameter covering the region from the inside diameter to some radius lying just inside the bolt holes, with that portion raised slightly above the remainder of the flange surface. This increases the effective load on the gasket and increases the sealing effectiveness. The gasket seating surface is usually serrated or grooved, either with concentric or phonographic (spiraling) serrations.

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

RJ or RTJ: Ring joint or ring-type joint-a flange sealing surface in which the gasket seating area is two narrow lines of metal-to-metal contact along a metal ring, softer than the flange, that is set into a groove in each flange face.

RMS: Root mean square-measure of surface roughness in units of microinches. Numerically close to AARH (arithmetic average roughness height) and often used interchangeably.

RT: Radiography or radiographic inspection-an examination procedure using X rays or, more usually, gamma rays from a radioactive source to produce an image on film of internal artifacts in an item. These images depict cracks, inclusions, porosity, and other defects that materially affect the apparent density in the direction that the view was taken.

SB: Screwed bonnet-a bonnet or cover that is attached to the body by threads, where the bonnet must be turned to engage the threads.

SCC: Stress corrosion cracking-damage or failure caused by cracking from the combined effects of localized stress and chemical action. Stresses can be live, from pressure or loads, or residual such as from welding. Chlorides on stainless steels and sulfides on many materials are the most common corrodents.

Schedule pipe: Pressure pipe with wall thicknesses described as a schedule such as schedule 40.

Sealant: A high-viscosity semisolid, such as a grease, used to fill a cavity and seal off the passage of more fluid substances.

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

Seat: The fixed component, mounted in the valve body, that the closure element contacts in order to close off flow.

Short pattern: When two different end-to-end lengths for a given product, such as a ball or plug valve, become established by custom or by standards publication, the shorter of the two is known as short pattern. The longer of the two is usually known as regular pattern and is usually more common.

Slurry: A mixture of solids in a liquid, with a high percentage of solids, not dissolved but being transported by the liquid as it flows.

Socket end: An end connection configured for socket-welding.

Socket weld: A strength or attachment weld in which the two components are assembled in a male- female configuration and a fillet weld is applied at the juncture of the two components.

Stellite: One of a number of hardfacing alloys, usually applied by weld deposition but sometimes investment cast as a solid component. Hardfacing alloys are covered in AWS A5.13, the common Stellite #6 being alloy CoCrA.

Stuffing box: Also known as packing box, the volume surrounding a shaft at the area on the shaft where it emerges from a pressurized or isolatable space, used to contain the packing.

SWP: Steam working pressure-an obsolete rating system that incorporated the effects of temperature by rating components in terms of the pressure of saturated steam they were capable of.

Teflon: Trademark of E.I. du Pont de Nemours Co. Inc. for polytetrafluoroethylene and related fluoropolymers.

Thermopiezo effect: The property of liquids, due to which a slight temperature rise of an entrapped liquid results in rapid pressure increase. Tests on fuel oil have shown that one degree increase in temperature causes the entrapped fluid pressure to increase by 75 psi.

Throttling: The act of reducing the pressure or flow rate of a fluid passing through a valve.

Through conduit: A gate valve that in the open position presents a smooth continuous circular cross section to the flow, suitable for passing pigs, scrapers, or other solid objects.

Torque: The rotational force imposed on or through a shaft.

Torsion: A twisting action in which the stresses produced in the part under stress are shear stresses.

Transflow: A multiport (more than two-port) valve design in which the flow passing between the common port and one of the other ports is not completely shut off before the third port begins to open. In other words, some flow is always present as the flow is being switched.

Trim: Any of the assorted small wetted parts in a valve, typically made of a higher alloy material for increased wear or corrosion resistance, analogous to the trim painting on a house.

UT: Ultrasonic test or ultrasonic inspect-on-an examination method that uses high-frequency sound waves passed into a material and reflected back to a detector. The reflected signals can be interpreted to determine the depth of any artifacts that produce a difference in sonic reflectivity, including the opposite side of the piece, laminations, some inclusions, or voids.

Venturi: A section of pipe line or valve that has a smaller cross section than that of the pipe on either side, with a smooth transition from one cross section to the other. Venturi valves have a smaller cross- sectional area in the seat area than at the end connections.

Viton: Trademark of E.I. du Pont de Nemours Co. Inc. for a fluoroelastomer rubber.

Water hammer: A phenomenon in which sudden closing of a valve or shutoff a pump produces severe shock waves in the liquid inside the piping. Water hammer can be heard by bystanders, but is primarily undesirable because of the mechanical damage it can do, not the noise.

Weld neck: A type of flange having a welding neck, where the hub is fairly thick at the point where it attaches to the flange and tapers down on the outside to the same diameter as the mating pipe. It is attached to the pipe by a circumferential butt weld (groove weld).

WOG: Water-oil-gas-one of the early rating designations, still in use today for small valves, chiefly in low ratings. Also called nonshock rating. Normally this rating is meant to be the maximum working pressure at ambient temperature (32° to 100°F).

Y-pattern: A design of globe or check valve in which the stem is included at 45 to 60 degrees from the axis of the end connections, as opposed to 90 degrees as in most valves. The two end connections are still on the same centerline. Not to be confused with an angle valve.

Section 2: General Information

1. Chemical Resistance Chart

Legend

A Substantial resistance - preferred material of construction.
B Moderate resistance - satisfactory for use under most conditions; very slight swelling of elastomers.
C Questionable resistance - use with caution.
D Inadequate resistance- not recommended.
X No information available.

1 All figures given, unless otherwise stated are for normal temperatures and pressures.
2 Applicable up to the boiling point of the solution.
3 Applicable up to 50°C only.
4 Air free.
5 Subject to pitting.
6 Ammonia free.
7 Ambient only.

The information given in the following tables, is a general guide to the chemical resistance of particular products manufactured by Audco India Limited. However, many factors, such as temperature, concentration of fluid and degree of agitation, can affect certain ratings in the table. We therefore advise that the ratings given be used as a guide to your choice of valve and not as an absolute answer.

In the column headed “Lubricants” general recommendations are given for the grade of Audco Lubricant to use in Audco Lubricated Taper Plug Valves on the services stated.

*EPDM also available in tasteless version suitable for potable water, food, brewing and distilling industries.

†For Lubricant Temperature Range and General Lubricant Information—See Page 49

	METALS																NON-METALS										LUBRICANT†	
				Stainless Steels					Nickel Alloys																			
	Cast iron	Mild steel	Audcoloy	18Cr/8Ni	18Cr/10Ni/3Mo	Ferralium	EN57 (17 Cr)	29 Ni/20Cr (Alloy 20)	Monel	Electroless nickel	Incoloy alloy 825	Hastelloy B	Hastelloy C	Aluminium bronze	Aluminium	Titanium	Nitrile	Viton	Hypalon	Nylon 11 (Coating)	Solef	PFA	Polyester (GRP)	PTFE	*EPDM	Polyurethane	Preferred Lubricant No.	Alternative Lubricant No.
Acetaldehyde	A	A	A	A	A	A	A	A	B	A	A	X	A	D	A	A	D	D	D	A1	A1	A	X	A	A	D	147	731
Acetate solvents	A1	A1	A1	A	A	A	A	A	A	A	A	A	A	A	A	A	D	D	D	A3	A	A	C	A	C	D	563	147
Acetic acid, 10%	D	D	D	B	A2	A	A	A	B	A	A	A2,4	A	A1	A3	A	B	B	A1	C	A	A	A7	A	A	B	731	147
Acetic acid, 60%	D	D	D	B	A	A	B	A	B	C	A	A2,4	A	A1	A3	A	B	C	D	D	A	A	A	A	C	C	731	147
Acetic acid, glacial	D	D	D	B	A	A	C	A	B	C	A	A2	A	A1	A3	A	C	D	D	D	A	A	A	A	C	D	731	147
Acetic acid vapours	D	D	D	C	A	A	A	A	B	A	X	X	A	B	C	X	B3	B	A1	X	A	A	X	A	B	B	731	
Acetic anhydride	D	D	D	B	A	A2	B	A	B	X	A	B1	A2	B	A3	A	D	D	D	C	A1	A	C	A	A	C	731	147
Acetone	A	B5	A	A	A	A	A	A	A	A	A	A	A	A	A	A	D	D	D	A1	A3	A	C	A	A	D	147	735
Acetylene	A	A	A	A	A	A	A	A	A	A	A	A	A	D	A	X	B	A	B	A	X	A	X	A	A	X	733	147
Acrylonitrile	B	A	A	A	A	A	A	A	A	X	A	A	A	B	A	A	D	D	C	X	D	A	C	A	D	X	147	
Adipic acid, 15-25%	X	D	X	A2	A2	X	A	X	X	X	X	X	X	X	A	A	X	A	A	X	X	A	X	A	X	X	731	147
Alcohols	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	A	B7	B	A	A	A	A	A	A	A	D	147	731
Aliphatic esters	A	A	A	A	A	A	A	A	A	A	A	B	B	A	C.	A	C	B	D	B	A	A	C	A	X	C	563	
Aliphatic hydrocarbons	A	B	B	A	A	X	A	A	A	A	A	A	A	B	A	A	A	A	B	B	A	A	A	A	D	A	733	563
Alkyl chlorides, pure	B	B	B	B5	A5	A	B5	A	A	A	A	A	B	A	C	X	C	B	C	C	A	A	A	A	D	D	563	
Alum	D	D	C	B	A	A	C	A	B	C	A	X	B	B	B5	A	A	A	A	A	A	A	A	A	A	A	731	734
Aluminium chloride	D	D	D	C5	B5	X	C	A3	B	C	A3	A2	A	B	D	A3	B	A	A	A1	A	A	A1	A	A	X	731	147
Aluminium sulphate	D	D	C	B	A	A	B	A	A	A	A	A	A	B	B	A	B	A	A	A1	A	A	A1	A	A	A	731	734

	METALS																NON-METALS										LUBRICANT†	
				Stainless Steels					Nickel Alloys																			
	Cast iron	Mild steel	Audcoloy	18Cr/8Ni	18Cr/10Ni/3Mo	Ferralium	EN57 (17 Cr)	29 Ni/20Cr (Alloy 20)	Monel	Electroless nickel	Incoloy alloy 825	Hastelloy B	Hastelloy C	Aluminium bronze	Aluminium	Titanium	Nitrile	Viton	Hypalon	Nylon 11 (Coating)	Solef	PFA	Polyester (GRP)	PTFE	*EPDM	Polyurethane	Preferred Lubricant No.	Alternative Lubricant No.
Amines	B	B	B	A	A	A	A	A	B	X	A	A	A	D	A	X	C	D	C	X	A1	A	B	A	B	X	Refer to SAV	
Ammonia (gas)	A	A	A	A	A	X	A	A	D	A	A	A	A	D	B	A	B	C	B	A3	X	A	X	A	A1	X	731	734
Ammonium bicarbonate	C	A	B	A	A	X	A	A	D	A	A	A	A	D	B	A	B	A	A	X	A	A	A	A	A	X	731	734
Ammonium carbonate	B	A	B	A2	A2	X	A	A	B	B	A	A2	A2	D	B	A	D	A	A	A	A	A	A	A	A	X	731	734
Ammonium chloride	C	D	C	C5	B5	A	C	A	A	B	A	A	A	D	B5	A	A	A	A	B	A1	A	A1	A	A	A	731	734
Ammonium hydroxide	A	A	A	A	A	A	A	A	C	A	A	A	A	D	A	A	A3	B	A	A	A	A	A	A	A	A	731	734
Ammonium nitrate, 10%	D	C	B	A	A	A2	A	A2	X	B	A	B	A	D	A	A	A1	A	A	A1	A	A	A1	A	A	X	731	734
Ammonium sulphate	D	D	B	D	A	A	B	A	A	A	A	A	A	D	B5	A	B	A	A	A3	A	A	A1	A	A	A	731	734
Amyl acetate	B	B	A	A	A	A	A5	A	A	A	A	A	A	A4	A	A	D	D	D	A	A	A	B	A	B	D	563	
Amyl chloride	B	B	B	B5	A5	A	B	A	A	A	A	A	A	B	B	X	D	D	D	B	X	A	C	A	X	X	563	
Aqua Regia	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	A1	D	B	C	D	D	A	X	A	X	D	147	
Aromatic hydrocarbons	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	D	B	D	A	A	A	B	A	D	D	563	
Barium chloride	C	C	B	B5	A5	X	A5	A	A	A	A	A	A	B	C	A	A3	A	A	A	A	A	A7	A	A	X	731	734
Barium hydroxide	B	B	A	A	A	A	A	A	A	A	A	A2	A2	C	C	A	A3	A	A	A	A	A	C	A	A	A	731	734
Barium nitrate	X	A1	X	A	A2	X	X	A	X	A	A	A	A	D	A2	A	A	A	A	X	A	A	X	A	A	X	731	734
Beer, 71°C	D	D	C	A	A	X	A	A	A	A	A	A	A	B	A	X	A	A	D	A	A	A	X	A	A	X	2A	
Benzene	B	B	B	A	A	A	A	A	A	A	A	A	A	A	A2	A	D	B	D	A	A	A	B	A	D	D	563	
Benzoic acid	D	D	B	A2	A2	X	A	A	A	X	A	A	A	B4	B	A	B	A	B	C	A	A	A	A	B	X	731	147
Boric acid	D	D	C	B	B	X	B	A	B4	B	A	A2	A2	B4	C	A	A	A	A	A	A	A	A7	A	A	A	731	147
Brines	C	D	B	C	C	A	B	A	A	B	A	A	A	A	B5	A	A3	A	A	A	A	A	A7	A	A	X	731	147
Bromine (dry)	D	D	B	D	D	X	D	C	A	D	A	A	A	B4	B	D	D	A	D	D	A	A	C	B	D	D	147	
Bromine (wet)	D	D	D	D	D	X	D	D	C	D	D	X	B	D	D	D	D	A	D	D	A	A	C	B	D	D	147	
Butadiene	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A3	A	C	A	A	A	X	A	D	D	563	733
Butane	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A3	A	A1	A	A	A	X	A	D	A	733	563 (Liquid)
Butyl acetate	B	B	B	A	A	A	A	A	A	A	A	A	A	A	A	A	D	D	D	A	A	A	B	A	C	D	563	
Butyl alcohol	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A1	B	A	B	A	A	A	A	A	D	147	734
Butyric acid	D	D	D	B	A2	X	A	A	A4	C	A	A2	A2	B	A1	A	C	B	C	B	A	A	A	A	D	X	147	731
Calcium bisulphite	D	D	D	C	A2	X	C	A	D	X	A	X	A	B	C	A	A	A	A	A	A	A	X	A	X	A	731	734
Calcium chloride	C	D	B	C5	B5	X	C5	A	A	B	A	A	A2	A4	B5	A	A3	A	A	B	A	A	A	A	A	A	731	734
Calcium hydroxide	B	B	B	B	A2	X	A	A	A	A	A	A	A2	B	A	A	A	A	A	A	A	A	A	A	A	A	731	734
Calcium hypochlorite	D	D	D	C5	B	X	C	B	C	X	B	X	A	D	D	A	D	A	A	D	A	A	A	A	X	X	147	731
Calcium nitrate	B	D	A	A	A	X	A	A	A	X	A	A	A	A	B	X	A	A	A	X	A	A	X	A	A	X	731	734
Carbolic acid	B	B	B	A5	A2	X	A	A	A	X	A	A2	A2	B	B	A1	D	A	D	D	A	A	D	A	C	D	731	733
Carbon disulphide	B	B	B	A	A	X	A	A	A	A	A	X	X	B	A2	A	D	A	D	D	A	A	A	D	D	X	563	
Carbonic acid	D	B4	B	A	A	X	A	A	A	X	A	A	A	B4	A	X	A	A	A	A	A	A	A	A	A	X	731	147
Carbon tetrachloride (dry)	B	A	A	A	A	A2	A	A2	A	A	A	A2	A2	B	B	A	D	B	D	C	A3	A	A	A	D	D	563	
Castor oil	B	B	A	A	A	A	A	A	A	A	A	A	A	A	A	X	A3	A	A3	A	A	A	X	A	C	A	731	2A
Chloric acid	D	D	D	D	D	D	D	B	D	D	B	D	A	D	D	X	D	B	D	D	X	A	X	A	X	X	147	
Chlorinated hydrocarbons	B	B	B	B	B	B	B	B	A	B	B	B	A	B	B	A	D	B	D	C	A3	A	B	A	D	D	563	
Chlorinated water(saturated)	D	D	X	C	C	X	C	B	C	D	B	X	A	C	C	A	C	B	C	D	B	A	A	A	C	D	731	734

	METALS																	NON-METALS											LUBRICANT†	
				Stainless Steels					Nickel Alloys																					
	Cast iron	Mild steel	Audcoloy	18Cr/8Ni	18Cr/10Ni/3Mo	Ferralium	EN57 (17 Cr)	29 Ni/20Cr (Alloy 20)	Monel	Electroless nickel	Incoloy alloy 825	Hastelloy B	Hastelloy C	Aluminium bronze	Aluminium	Titanium	Nitrile	Viton	Hypalon	Nylon 11 (Coating)	Solef	PFA	Polyester (GRP)	PTFE	*EPDM	Polyurethane	Preferred Lubricant No.	Alternative Lubricant No.
Chlorine (dry gas)	B	B	B	B	B	B	B	A	A	B	C	X	A	B4	B	C	D	B	D	D	A	A	A	A	C	D	731	147
Chlorine (wet gas)	D	D	D	D	D	D	D	D	C	D	D	D	B	D	D	A	D	B	D	D	D	A	A	A	D	D	731	147
Chlorine dioxide	D	D	D	D	D	D	D	C5	C	D	D	B	A	D	X	A	D	B	D	D	X	A	A	A	X	D	147	
Chloroacetic acid	D	D	D	D	D	D	D	D	B	D	D	A	A	D	D	A	D	C	D	D	A1	A	B	A	C	D	147	
Chlorobenzene (dry)	B	B	B	A	A	A	A	A	A	A	A	A	A	A	A	A	D	A	D	A	A	A	X	A	D	D	563	
Chloroform (dry)	B	B	B	A	A	A	A	A	A	A	A	A2	A2	A4	D	A	D	B	D	D	A	A	A	D	B	D	D	563	
Chlorosulphonic acid	D	D	D	D	C5	X	D	B	B	X	B	A	B	C4	B	X	D	D	D	D	D	A	D	A	D	D	Refer to SAV	
Chromic acid, dilute	C	C	D	B	A	A	B	A	C	X	A	A	A	D	B	A	D	A	B	C	A	A	A	A	C	D	731	147
Chromic acid > 50%	B	B	D	C	C	B	C	B	C	X	B	D	B	D	D	A	D	A	B1	D	A	A	D	A	D	D	147	731
Citric acid	D	D	D	B	A	A2	B	A2	A	B	A	A2	A2	B4	C	A	A	A	D	A3	A	A	A	A	A	X	731	147
Copper chloride	D	D	D	D	D	D	D	D	D	X	D	D	A	D	D	A	A3	A	A	B	A	A	A	A	A	A	731	734
Copper nitrate	D	D	D	A2	A2	X	B	A	D	X	A	X	A	D	D	A	A3	A	A	B	A	A	A	A	A	X	731	734
Copper sulphate	D	D	D	A2	A2	A	A	A	C	B	A	X	A1	D	D	A	A3	A	A	B	A	A	A	A	A	A	731	734
Creosote (hot)	B	B	B	A	A	X	B	A	A	B	A	A	A	B	A	X	B	A	D	C	X	X	D	A	D	X	733	
Cresol	C3	C3	C3	A	A	A	B	A	B	A	A	A	A	B	A	X	D	A	D	D	X	A	D	A	D	D	563	733
Cresylic acid	C3	C3	C3	A2	A2	A	B	A	B	A	A	A2	A2	B	A	X	D	A	D	D	X	A	D	A	D	D	563	733
Cyanide solutions	D	D	D	A	A	X	X	A	D	X	A	X	B	D	B	X	X	A	A	A	A	A	A	A	A	X	731	147
Cyclohexane	B	B	B	A	A	A	A	A	A	A	A	A	A	A	A	X	B	A	D	A	A	A	A	A	D	A	563	733
Detergents, synthetic	B	B	B	A	A	X	A	A	B	A	A	A	A	A	B	X	A3	A	A	A	A	A	A	A	A	D	735	
Diacetone alcohol	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	X	D	C	C	B	C	A	X	A	B	C	147	731
Dichlorobenzene	B	B	B	B	B	B	B	A	A	B	A	A	A	A	A	X	D	B	D	B	A	A	D	A	D	C	563	
Dichloroethylene	B	B	B	A	A	A	B	A	A	B	A	A	A	B	B	X	D	B	D	A	X	A	X	A	D	C	563	
Diesel oil	B	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	D	A	A	A	A	A	A	D	B	733	2591
Diethylamine	B	B	B	A	A	X	A	A	D	X	A	X	A	D	A	A	C	D	C	X	B	A	A	A	A	B	D	563	735
Diethylene glycol	B	B	B	A	A	X	B	A	A	A	A	A	A	B	A	A	A	A	A	A	A	A	A	A	A	B	731	734
Esters	B	B	B	A	A	A	A	A	B	A	A	A	A	A	C	A	C	C	D	A	A	A	B	A	B	C	563	
Ethers	A	A	A	A	A	A	A	A	A	A	A	A	A	B	A	X	D	D	D	B	A	A	C	A	D	D	563	
Ethyl acetate	B	B	B	A	A	A	A	A	A	A	A	A	A	A	B	A	D	D	D	A	A	A	C	A	C	D	563	
Ethyl alcohol	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B5	A	A1	A	A	A	A	A	A	A	A	C	147	
Ethyl chloride (dry)	B	B	B	A	A	A	A	A	A	A	A	.	A	B	B	A	C	A	C	B	A	A	A	A	C	C	563	
Ethyl chloride (wet)	D	D	D	B	B	A	B	A	B	C	A	A	A	C	D	A	D	B	D	B	A	A	D	A	C	C	563	
Ethylene glycol	B	B	A	A	A	X	A	A	A	A	A	A	A	B	A	A	A3	A	A	B	A	A	A	A	A	B	731	147
Fatty acids	D	D	B	B5	A	X	A	A	B	D	A	A	A	B	B	A	C	A	D	B	A	A	A	A	D	X	731	733
Ferric chloride	D	D	D	D	D	D	D	D	C	C	D	D	B	D	D	A	A	A	A	X	A	A	A	A	A	A	731	734
Ferric nitrate	D	D	X	B	A	A	B	A	D	D	A	C	A	D	D	A	A	A	A	A	A	A	A	A	A	B	731	734
Ferric sulphate	D	D	D	B2	A2	A2	A	A	D	D	A	D	A	D	D	A	A	A	A	A	A	A	A	A	A	B	731	734
Ferrous sulphate	D	D	X	B5	B	X	B5	A	B	D	A	A	A2	B4	D	A	A	A	A	A	A	A	A	A	A	A	731	734
Fluorinated hydrocarbons (Freons)	B	B	B	B	B	X	X	B	A	B	B	A	A	B	B	X	C	C	A	B	X	A	A	A	C	X	563	2515
Fluorine (dry gas)	D	D	X	B	A	X	B	A	A	D	A	B	A	B	D	D	D	D	D	D	D	A3	D	A3	D	D	Refer to SAV	
Fluorine (wet gas)	D	D	D	D	D	X	X	X	A	X	X	B	A	D	D	X	D	D	D	D	D	A3	D	A3	D	D	Refer to SAV	

	METALS																	NON-METALS											LUBRICANT†	
				Stainless Steels					Nickel Alloys																					
	Cast iron	Mild steel	Audcoloy	18Cr/8Ni	18Cr/10Ni/3Mo	Ferralium	EN57 (17 Cr)	29 Ni/20Cr (Alloy 20)	Monel	Electroless nickel	Incoloy alloy 825	Hastelloy B	Hastelloy C	Aluminium bronze	Aluminium	Titanium	Nitrile	Viton	Hypalon	Nylon 11 (Coating)	Solef	PFA	Polyester (GRP)	PTFE	*EPDM	Polyurethane	Preferred Lubricant No.	Alternative Lubricant No.
Fluosilicic acid	D	D	B	C5	B	X	C5	B	B	D	B	A	A	D	D	D	X	X	A	D	A	A	A	A	X	X	147	731
Formaldehyde, 40%	D	D	B	B	B	X	B	A	A	D	A	B	B	B	B	A	A3	A	A1	A	A	A	A	A	A	C	147	731
Formic acid < 50%	D	D	D	B5	A5	A	D	A	A	D	A	B	A	B4	C	C	C	C	A	D	A	A	B	A	A	D	147	731
Formic acid > 50%	D	D	D	C5	A5	A	D	B	A	D	A	B	A	B4	C	C	C	D	A1	D	A	A	C	A	B	D	147	731
Fruit juices	D	D	D	A	A	X	A	A	B	D	A	A	A	B	B	X	A1	A	D	A	A	A	X	A	A	X	2A	
Fuel oil	B	B	A	A	A	X	A	A	A	A	A	A	A	B	A	A	A3	A	D	A	A	A	A	A	D	B	733	563
Furfural	B3	C3	B	A2	A2	X	A	A	A	A	A	A	A	B	A	A	D	D	B	A	A	A	B	A	B	C	147	735
Gallic acid, 25%	D	D	D	A2	A2	X	A	A	X	X	X	A	A2	X	A	X	X	B	A	X	X	X	X	A	D	X	731	147
Gelatine	D	C	X	A	A	X	A	A	A	A	A	A	A	B	A	A	A	A	D	A	X	A	A	A	A	A	2A	147
Glucose	A	B	X	A	A	X	A	A	A	A	A	A	A	A	A	A	A	A	D	A	A	A	A	A	A	A	2A	731
Glycerine	B	B	A	A	A	A	A	A	A	A	A	A	A	B	A	A	A1	A	D	A	A	A	A	A	A	A	2A	731
Glycols	B	B	A	A	A	A	A	A	B	A	A	A	A	A	A	A	A	A	A	B	A	A	A	A	A	B	731	734
Hydrobromic acid	D	D	D	D	D	D	D	D	C	D	C	A	B	D	D	A	D	A	A	D	A	A	A	A	A	D	731	147
Hydrochloric acid < 10%	D	D	D	D	D	D	D	C	C	D	D	A	B	D	D	B	D	A	A1	C	A	A	A '	A	A	D	731	147
Hydrochloric acid > 10%	D	D	D	D	D	D	D	D	D	D	D	A	C	D	D	D	D	A	D	D	B	A	A	A	A	D	731	147
Hydrocyanic acid	D	D	D	A	A	X	D	A	C	D	A	X	A	D	A	X	D	A	A	D	A	A	A	A	A	X	731	147
Hydrofluoric acid < 40%	D	D	D	D	D	D	D	C	A	D	C	A	A	D	D	D	D	A	A	D	A	A	C	A	C	D	147	
Hydrofluoric acid > 40%	D	D	D	D	D	D	D	C	A	D	C	A	A	D	D	D.	D	B	D	D	C	A	X	A	D	D	147	
Hydrogen chloride (dry)	B	A	B	A	A	X	A	A	A	B	A	A	A	B	D	X	X	A	D	D	A	A	A	A	X	X	731	
Hydrogen chloride (wet)	D	D	D	D	D	D	D	C	D	D	A	A	D	D	D	X	X	A	D	X	A	A	A	A	B	X	731	147
Hydrogen peroxide	D	D	X	B	B	A	B	A	B	D	A	C	A	D	A	D	D	A	B	C	A	A	A	A	X	X	147	
Hydrogen sulphide (dry)	B	B	B	A	A	X	A	A	B	B	A	B	A	B	B	A	B	B	B	B	A	A	A	A	A	X	731	
Hydrogen sulphide (wet)	D	D	B	A	A	X	B	A	D	D	A	A	A	C	C	A	D	B	B	B	A	A	A	A	B	X	731	
Hypochlorites	D	D	D	D	D	D	D	D	D	D	D	C	A	D	C	A	D	C	A	D	A	A1	D	A	A	B	D	731	147
Hypochlorous acid	D	D	D	D	D	D	D	D	D	D	D	C	A	D	D	A	D	A	A1	D	A	A	X	A	B	X	731	147
Iodine (wet)	D	D	D	D	D	D	D	C	D	D	D	X	B	D	C	X	B	A	A	B	A	A	X	A	B	X	147	731
Ketones	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A2	A	D	D	D	A	A	A	C	A	B	D	147	563
Lactic acid, 10%	D	D	D	B5	A5	A	C	A	C	D	A	A2	A	D	C	A	C	A	A	A	A	A	A	A	B	X	731	
Lead acetate	D	D	X	A	A	X	A	A	B	D	A	A	A	D	D	A	B3	A	A	B	A	A	A	A	A	X	731	734
Lead nitrate, 50%	D	D	X	A2	A2	X	A	A	A	D	A	A	A	X	D	X	A	A	A	X	A	A	A	A	A	X	731	734
Lime	B	B	B	B	A2	X	A	A	A	B	A	A	A2	B	A	A	A7	A	A	A	A	A	A	A	A	A	731	734
Linseed oil	A	A	A	A	A	A	B	A	B	A	A	A	A	B	A	X	A3	A	C	A	A	A	A	A	D	B	731	563
Lithium bromide	C	D	B	C5	B5	X	C5	A	A	B	A	A	A2	A4	B5	A	A3	A	A	B	A	A	A	A	A	A	731	734
Lithium chloride	C	D	B	C5	B5	X	C5	A	A	B	A	A	A2	A4	B5	A	A3	A	A	B	A	A	A	A	A	A	731	734
Lubricating oils	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	A	A	X	A	D	B	733	2591
Magnesium carbonate	B	B	B	A	A	A	A	A	A	A	A	A	A2	B	B	A	A3	A	A	A	A	A	A	A	A	A	731	734
Magnesium chloride	D	C	B	C5	B5	A	C5	A	B	D	A	A2	A2	A4	C5	A	A3	A	A	A	A	A	A	A	A	A	731	734
Magnesium hydroxide	C	B	B	A	A	A	A	A	A	A	A	A	A	B4	D	A	A3	A	A	A	A	A	X	A	A	A	731	734
Magnesium nitrate	C	B	X	A	A	A	B	A	B	C	A	D	A	D	B	A	A3	A	A	X	A	A	A	A	A	X	731	734
Magnesium sulphate	D	B	B	A	A	A	A	A	A	A	A	A2	A2	B4	B	A	A3	A	A	A	A	A	A	A	A	X	731	734

	METALS																NON-METALS											LUBRICANT†	
				Stainless Steels					Nickel Alloys																				
	Cast iron	Mild steel	Audcoloy	18Cr/8Ni	18Cr/10Ni/3Mo	Ferralium	EN57 (17 Cr)	29 Ni/20Cr (Alloy 20)	Monel	Electroless nickel	Incoloy alloy 825	Hasteloy B	Hasteloy C	Aluminium bronze	Aluminium	Titanium	Nitrile	Viton	Hypalon	Nylon 11 (Coating)	Solef	PFA	Polyester (GRP)	PTFE	*EPDM	Polyurethane	Preferred Lubricant No.	Alternative Lubricant No.
Maleic acid	D	C	C	B5	B	X	B	B	A	A	A	A2	A2	B	C	A	B	A	C	C	A	A	A	A	D	X	731	147
Malic acid	D	D	X	A	A	X	C	A	B4	D	A	A	A	B	A1	X	A	A	B	X	X	X	A	A	D	X	731	147
Mercuric chloride	D	D	D	C5	C5	X	D	D	C	D	C	D	A	D	D	A	A1	A	A	C	A	A	A	A	A	X	731	147
Mercuric cyanide, 5%	D	D	X	A	A	X	C	A	C	D	A	A	A	D	D	A	B	A	A	X	A	A	X	A	A	X	731	734
Mercuric iodide	D	D	X	X	X	X	X	X	C	C	C	X	A	X	D	C	X	A	A	X	A	B	X	A	A	X	731	734
Mercuric nitrate, 5%	B	B	X	A	A	X	A	A	B	B	A	C	A	D	D	X	B	A	A	X	A	A	X	A	A	X	731	734
Mercurous nitrate, 5%	D	D	D	X	A	A	X	A	C	D	A	X	A	D	D	A	X	A	A	X	A	A	X	A	X	X	731	734
Mercury	A	A	A	A	A	A	A	A	B	X	A	B	A	D	D	A	A	A	A	A	A	A	A	A	A	A	731	733
Methyl alcohol	A	A	B	A	A2	A2	A	A	A	A	A	A2	A	A	B	A	A1	A	A	A	A	A	A	A	A	D	147	
Methyl chloride (dry)	B	B	B	B	B	A	A	A	A	B	A	A	A	B	D	X	D	D	C	C	A	A	A	A	D	D	563	
Methylene chloride (dry)	B	B	B	B	A	A	A	A	A	B	A	A	A	A	C	X	D	C	D	C	A	A	D	A	D	D	563	
Methyl ethyl ketone	A	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	D	D	D	A3	A	A	C	A	A	D	147	563
Methyl isobutyl ketone	B	B	B	B	A	A	A	A	B	B	A	A	A	A	A	A	D	D	D	A3	A	A	B	A	A	D	147	563
Methyl methacrylate	C	C	C	C	A	A	A	X	X	C	X	X	X	X	A	X	D	D	D	A	A	A	C	A	D	D	563	
Milk	D	D	D	D	A	A	X	A	A	A	A	X	X	C	A	A	A1	A	D	A	A	A	X	A	A	D	2A	
Mixed acids (nitric & sulphuric)	B	D	D	X	B	B	B4	B	D	D	A	D	B2	D	B	B	D	A	C	D	A	A	A	A	C	D	147	
Molasses	B	B	B	B	A	A	X	A	A	A	A	A	A	B	A	A	A3	A	D	A	A	A	A	A	B	X	2A	731
Naphtha	B	B	B	B	A	A	A	A	A	B	A	A	X	B	A	A	D	A	D	A	C	A	A	A	D	B	563	
Naphthalene	B	B	B	B	B	B	X	B	A	B	A	X	A	B	A	A	D	B	D	A	C	A	A	A	D	B	733	735
Nickel chloride	D	D	D	D	C5	B5	X	B	A	D	A	A	A	D	D	A	A	A	A	A	A	A	A	A	A	X	731	734
Nickel nitrate, 5 10%	X	D	D	D	A	A	B	B	C	A	A	B	A	D	D	A	A	A	A	A	A	A	A7	A	A	X	731	734
Nickel sulphate	D	D	D	D	A2	A2	A	A	A	A	A	X	A	B4	D	A	A	A	A	A	A	A	A7	A	A	X	731	734
Nitric acid • 25%	D	D	D	A	A	A	A2	A	C	A	A	D	A	D	D	A.	D	A	A1	D	A	A	C	A	C	D	147	731
Nitric acid, 70%	D	D	D	A3	A	A	A2	A	C	A	A	D	A	D	D	A	D	A	D	D	B	A	D	A	D	D	147	731
Nitric acid, 100%	D	D	D	B	A	A	A	A	C	B	A	D	C	D	A	C	D	B	D	D	D	D	D	A	D	D	147	
Nitrobenzene	B	B	B	A	A	A	A	A	A	A	A	D	A	B4	A	A	D	C	D	C	A	A	A	A	D	D	563	
Nonylphenol	X	X	X	A	A	X	X	X	X	X	X	X	X	X	X	X	X	A	C	X	A	A	X	A	X	X	733	
Oils, essential	A	B	X	A	A	X	X	X	A	A	A	X	X	A	B	A	B	B	C	A	A	A	X	A	X	X	563	733
Oils, mineral	B	B	B	A	A	A	A	A	A	A	A	A	A	B	A	A	A1	A	B	A	A	A	A	A	D	A	733	2591
Oils, vegetable and animal	B	B	B	A	A	A	A	A	A	A	A	A	A	B	A	A	A1	A	B	A	A	A	A	A	D	X	731	2A
Oleic acid	C	C	C	B	B	B	B	A	A	A	A	B	A	B	A2	A	A	B	B	A	A	A	A	A	C	B	731	733
Oleum	D	C	B	B	B	A	B	B	C	B	A	A	A	D	B	A	D	B	D	D	B	A	D	A	D	D	147	
Oxalic acid< 10%	D	D	D	B1	B1	A	B1	A1	A4	C	A	A2	A2	B4	C	B	B1	A	A	B	A	A	A1	A	A	X	731	147
Oxalic acid> 10%	D	D	D	B1	B1	B	B1	A1	A	C	B	A2	A2	B4	D	B	B1	A	A	C	A	A	A	A	A	X	731	147
Oxalic acid, 50% boiling	D	D	D	D	C	B	X	B	A	X	X	A	A	B4	D	X	D	C	B	X	X	X	X	A	X	X	731	
Palmitic acid	C	C	B	B	A	X	B	A	B	C	A	B	B	B	B	X	B	A	B	A	A	A	A	A	A	B	A	733	
Paraffins	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A1	A	B	A	A	A	A1	A	D	X	733	563
Petrol	B	B	B	A	A	A	A	A	A	A	A	A	A	A	A	A	B	A	D	A3	A	A	A	A	D	B	563	733
Phenol	D	C	B	A	A	X	A	A	A	B	A	A2	A2	B	B	A	D	A	D	D	A	A	D	A	B	D	731	733
Phosphoric acid, 10%	D	D	D	A	A	A2	A	A2	B	A	A	A2	A2	C4	D	B	B	A	A	D	A	A	A1	A	A	A	147	735

	METALS																NON-METALS											LUBRICANT†	
				Stainless Steels					Nickel Alloys																				
	Cast iron	Mild steel	Audcoloy	18Cr/8Ni	18Cr/10Ni/3Mo	Ferralium	EN57 (17 Cr)	29 Ni/20Cr (Alloy 20)	Monel	Electroless nickel	Incoloy alloy 825	Hasteloy B	Hasteloy C	Aluminium bronze	Aluminium	Titanium	Nitrile	Viton	Hypalon	Nylon 11 (Coating)	Solef	PFA	Polyester (GRP)	PTFE	*EPDM	Polyurethane	Preferred Lubricant No.	Alternative Lubricant No.
Phosphoric acid, 30%	D	D	D	A	A	A2	A	A2	A	A	A	A2	A2	D	D	C	C	A	A1	D	A	A	A7	A	A	A	147	735
Phosphoric acid, 50%	D	D	D	C	A	B2	C	B2	A	C	A	A	A	D	D	C	C	A	A1	D	A	A	A	A	A	A	147	735
Phosphoric acid, 10% boiling	D	D	D	C	B	A	B	A	A	D	A	A	A	D	D	X	D	A	C	D	A	A	X	A	B	D	735	731
Phosphorus trichloride, dry	B	B	B	B	B	X	B	B	B	X	X	A	X	C	C	A	D	B	C	X	A	A	D	A	A	X	147	
Phthalic acid	D	C	X	B	A	X	B	B	B	D	X	A	A	D	A	X	C	A	B	B	A	A	A1	A	D	X	733	731
Picric acid	D	D	D	B	A	A	B	A	C	C	A	B	A	D	B	X	B	A	A	D	A	A	A	A	B	B	731	147
Potassium bromide	D	D	B	A3	A3	X	A	A	B4	D	A	X	A	B4	B	A	A3	A	A	A	A	A	A	A	A	A	731	734
Potassium carbonate	B	B	B	A2	A2	A	B	A	A	A	A	A2	A2	B4	B	A	A	A	A	A	A	A	A	A	A	A	731	734
Potassium chlorate	C	D	B	C5	B5	X	A	C	A	A	A	C	A	B	A2	A	D	A	A	X	A	A	A7	A	A	A	731	734
Potassium chloride	C	D	B	C5	B5	A2	B	A	A	A	A	A2	A2	B	B5	A	A	A	A	A	A	A	A7	A	A	A	731	734
Potassium chromate	B	B	B	A	A	X	A	A	A	B	A	A	A	C	A2	A	D	A	A	B	A	A	A	A	A	X	731	734
Potassium cyanide	D	D	X	A	A	X	A	A	B4	B	B	A	X	D	C	B	A	A	A	X	A	A	A7	A	A	A	731	734
Potassium dichromate	C	C	B	A	A	X	B	A	C	C	A	C	B2	C	A	B	A	A	A	B	A	A	A	A	B	A	731	734
Potassium ferricyanide, 25%	C	D	X	A5	A2	X	A5	A	A	A	A	B	A	B	A2	B	X	A	A	A	A	A	A	A	A	X	731	734
Potassium hydroxide, 10%	B3	B3	B2	B	A	X	A	B2	A2	A	A	A2	A2	B	D	A	A	B	A	A	A	A	A	A	A	A	734	731
Potassium hydroxide, 50%	C3	C3	B3	B2	B2	X	B	B2	A2	C	B	A2	B	C	D	B	D	C	A1	C	A3	A	X	A	B	X	734	731
Potassium nitrate	B	B	B	A2	A2	X	A	A	A	A	A	D	A2	B	A	A	A1	A	A	A	A	A	A7	A	A	X	731	734
Potassium permanganate, dilute	B	B	B	A2	A2	X	B	A	B	B	A	X	A	B	A	A	C	B	A	D	A	A	A	A	A	X	731	734
Potassium silicate	B	B	B	A	A	X	A	A	A	B	A	A	A	B	A	A	B	A	A	A	A	A	A	A	A	X	731	734
Potassium sulphate	D	B	B	A2	A2	X	A	A	A	A	A	A	A	B	A	A	A3	A	A	A	A	A	A7	A	A	X	731	734
Propane	B	B	A	A	A	X	A	A	A	A	A	A	A	A	A	A	A	A	B	A	A	A	A	A	D	X	733	563 (Liquid)
Propyl acetate	B	B	B	A	A	A	A	A	A	A	A	A	A	A	A	X	D	D	D	A	A	A	X	A	X	X	563	
Propyl alcohol	B	B	A	A	A	A	A	A	A	A	A	A	A	A	A2	A	A	A	A	A	A	A	A	A	A	X	147	
Pyndine	B	B	X	A	A	X	A	A	A	B	A	A	A	C	B	X	D	D	D	A	A3	A	D	A	B	X	2A	735
Pyrogallic acid	D	D	D	A	A	X	A	A	B	D	A	A2	A2	B	B	X	B	A	C	X	A	A	X	A	C	X	147	731
Salicylic acid	D	D	B	A	A	B	B	A	A	D	A	B	A	B	B	X	A	A	A	A	A	A	X	A	A	X	731	147
Sea water	D	D	B	B	B	A	B	A	A	A	A	A	A	A	A	A	A1	A	A	A	A	A	A	A	A	A	731	734
Silicones	A	A	A	A	A	A	A	A	A	A	A	A	A	A	.A	A	A7	A	A	A	B	A	A	A	A	A	563	733
Silver bromide	D	D	D	D	D	D	D	B	A	D	B	B	A	D	D	X	A	A	A	X	A	A	X	A	X	X	731	734
Silver chloride	D	D	D	D	D	D	D	B	B	D	B	B	A	D	D	X	A	A	A	X	A	A	X	A	X	X	731	734
Silver nitrate	D	D	X	B	B	X	B	A	C	A	A	A	B	D	D	A	B	A	A	A	X	A	A7	A	A	X	731	734
Soaps	B	B	B	A.	A	A	B	A	A	A	A	A	A	A	C	A	A	A	A	A	A	A	X	A	A	A	731	734
Sodium acetate	C	C	B	A2	A2	X	A	A	A	A	A	X	A	B	B	A	B	C	B	A	A	A	A	A	A	X	731	734
Sodium aluminate	B	C	B	B	B	X	B	A	B	B	A	A	A	B	D	A	A	A	A	A	A	A	X	A	A	X	731	734
Sodium bicarbonate	C	C	B	A	A	X	A	A	A	A	A	A2	A2	A	A	A	B	A	A	A	A	A	A	A	A	A	731	734
Sodium bisulphate	D	D	B	B	B	X	B	A	A	B	A	A2	A2	B4	C	B	A	A	A	A	A	A	A	A	A	X	731	734
Sodium bisulphite	D	D	D	A	A	X	A	A	B	X	X	X	A	B	C	X	A	A	A	A	A	A	A7	A	A	X	731	734
Sodium borate, hot	C	C	B	A	A	A	A	A	A	C	A	A	A	B	C	A	A	A	A	A	A	X	A	A	A	A	731	734
Sodium bromide	D	B	B	B	B	X	B	B	A	B	B	A2	A2	B	B5	B	A	A	A	A	A	A	A	A	A	X	731	734
Sodium carbonate	B	B	B	A2	A2	X	A	A	A	B	A	A2	A	B	D	B	A	A	A	B	A	A	A	A	A	A	731	734

	METALS																	NON-METALS										LUBRICANT†	
				Stainless Steels					Nickel Alloys																				
	Cast iron	Mild steel	Audcoloy	18Cr/8Ni	18Cr/10Ni/3Mo	Ferralium	EN57 (17 Cr)	29 Ni/20Cr (Alloy 20)	Monel	Electroless nickel	Incoloy alloy 825	Hasteloy B	Hasteloy C	Aluminium bronze	Aluminium	Titanium	Nitrile	Viton	Hypalon	Nylon 11 (Coating)	Solef	PFA	Polyester (GRP)	PTFE	*EPDM	Polyurethane	Preferred Lubricant No.	Alternative Lubricant No.
Sodium chloride	D	D	B	C5	B5	A2	C5	A	A	C	A	B	A	A	B5	A	A1	A	A	A	A	A	A7	A	A	A	731	734
Sodium chromate	B	B	B	A	A	X	A	A	B	B	A	A	A	C	A	A	A	A	A	B	A	A	A	A	A	A	731	734
Sodium cyanide	C	D	X	A	A	X	B	A	C	C	A	X	X	D	B	A	A	A	A	A	A	A	X	A	A	X	731	734
Sodium dichromate	C	C	B	A	A	X	B	A	C	C	A	D	B2	C	A	B	A	A	A	B	A	A	A	A	B	A	731	734
Sodium hydroxide < 30%	B	B	A	A	A	A2	A	A2	A	A	A	A2	A2	B1	D	A	B	A	A	B	A	A	A	A	A	A	734	731
Sodium hydroxide > 30%	C	B	B	B	B	B	B	A1	A	B	A	A1	B	B	D	B	B	B	A	B	A	A	A	A	A	B	734	731
Sodium hypochlorite	D	D	D	C5	C5	D	C5	C5	D	D	D	C	A	D	C	A	C	A	A	D	A	A	A	A	A3	C	731	147
Sodium metaphosphate	C	C	C	A	A	X	B	A	A	A	A	A	A	B	A	A	X	A	A	X	A	A	X	A	A	A	731	734
Sodium metasilicate	B	B	B	A	A	A	B	A	A	B	A	A	A	B	A	X	A	A	A	X	A	A	X	A	A	X	731	734
Sodium nitrate	B	B	B	A2	A2	X	A	A	B	B	A	X	A	C	A	A	C	A	A	A	A	A	A7	A	A	X	731	734
Sodium nitrite	B	B	B	A2	A2	A	B	A	B	B	A	X	A	B	A	A	D	A	A	X	A	A	A	A	A	X	731	734
Sodium perborate	B	B	B	A	A	X	B	A	A	B	A	A2	A	B	A	X	C	A	B	B	A	A	X	A	A	X	731	734
Sodium peroxide, 10%	D	D	X	A	A	X	B	A	A	C	A	A2	A2	D	D	X	C	A	A	X	A	A	X	A	A	X	731	734
Sodium phosphate, tribasic	C	B	B	B	B	X	B	A	A	A	A	A2	A	C	D	A	B	A	A	A	A	A	A7	A	A	X	731	734
Sodium sulphate	B5	B	B5	B	A	X	B	A	A	B	A	A2	A	B	B	A	A	A	A	A	A	A	A7	A	A	X	731	734
Sodium sulphide	C	C	C	B5	B	X	B	A	B	C	A	A1	C	D	D	A	B	B	A	A	A	A	B	A	A	X	731	734
Sodium sulphite	B	B	C	A1	A1	X	B	A2	B	B	A	X	A	C	B	A	B3	A	A	X	A	A	A	A	A	X	731	734
Sodium thiosulphate	D	D	X	A	A	X	B	A	B	X	X	A	A	B	A	X	B	A	A	A	A	A	X	A	A	X	731	734
Stannic chloride	D	D	D	C5	B5	X	X	B	C	D	B	B	A	D	D	X	A	A	B	C	A	A	A	A	B	X	731	734
Stannous chloride	D	D	D	C5	B5	X	X	A	C	D	B	B	A	D	D	X	A	A	B	X	A	A	A	A	B	X	731	734
Starch	C	A	A	A	A	A	A	A	A	C	A	A	A	B	A	A	A3	A	A	A	A	A	X	A	A	A	731	2A
Steam	B	B	A	A	A	A	A	A	A	A	A	A	A	B	A	A	C	C	C	B	A	A	X	A	A	X	734	2608
Stearic acid	C	B	C	A	A	X	B	A	C	B	A	A	A	C4	A	A	B	A	B	A1	A	A	A	A	B	A	731	2608
Sugar liquors	B	B	B	A	A	X	A	A	A	A	A	A	A	B	A	A	A	A	D	A	A	A	X	A	A	X	2A	731
Sulphonic acids	D	D	C	B	B	X	B	B	X	B	A	B	A	X	C	B	X	X	X	D	D	X	A	A	X	X	731	147
Sulphur (fused)	C	C	B	B5	A	X	B	A	A4	C	A	A	A	D	A	A	D	A	A	D	X	X	A	A	A	X	735	2A
Sulphur dioxide (dry)	C	B	B	A	A	X	A	B	B	D	B	B	A	B5	A	B	D	A	B	C	A	A	A	A	A	X	733 731	147 (Liquid)
Sulphur dioxide (wet)	D	D	D	C	B	X	C	B	D	D	B	C	A	D	B	B	D	B	B	C	A	A	A	A	A	X	733 731	147 (Liquid)
Sulphuric acid < 5%	D	D	D	C1	B3	A	D	A2	A4	D	A	A	A	C	C	B	D	A	A	C	A	A	A1	A	A	X	147	731
Sulphuric acid, 5-20%	D	D	B1	D	C1	A	B2	A	A4	D	A	A	A	C4	D	C	D	A	A	D	A	A	A7	A	A	D	147	731
Sulphuric acid, 20-80%	D	D	B3	D	D	A	B2	B	B	D	B	A	B	C4	D	C	D	A	B1	D	A	A	B	A	B1	D	147	
Sulphuric acid > 80%	B3	B3	B2	B3	B3	A	B2	A	C	B3	A	A	B	D	C	C	D	A	C	D	A	A	D	A	D	D	147	
Sulphuric acid, fuming	D	B	C3	B	B	B	B	B	D	D	B	B	A	D	B	D	D	A	D	D	D	A	D	A	D	D	147	
Sulphurous acid	D	D	D	B	B	X	B	A2	X	C	A	D	A	C	C	X	B	A	A	D	A	A	A7	A	B	C	731	147
Sulphur trioxide (dry)	D	B	B	D	B	X	C	A	B	D	A	B	A	C	A	X	D	A	C	C	B	A	A	A	B	X	733	147 (Liquid)
Tannic acid	D	C	X	B	B	X	B	B	B	B	B	B	B	B4	C	B	B	A	A	A	A	A	A	A	A	A	731	733
Tar (hot)	B	B	B	A	A	X	A	A	B	A	A	A	A	B	A	X	C	A	D	C	A	A	X	A	D	X	2591	735
Tartaric acid	D	D	B	A	A	X	B	A	A4	B	A	B	B	B	B	B	B	A	A	B	A	A	A	A	B	A	731	147
Tetrahydrofuran	B	B	B	B	B	B	B	A	B	B	A	A	A	X	X	X	C	D	D	A	X	D	X	A	D	C	563	
Toluene	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	D	B	D	A	A	A	A	A	D	D	563	

	METALS																	NON-METALS										LUBRICANT†	
				Stainless Steels					Nickel Alloys																				
	Cast iron	Mild steel	Audcoloy	18Cr/8Ni	18Cr/10Ni/3Mo	Ferralium	EN57 (17 Cr)	29 Ni/20Cr (Alloy 20)	Monel	Electroless nickel	Incoloy alloy 825	Hasteloy B	Hasteloy C	Aluminium bronze	Aluminium	Titanium	Nitrile	Viton	Hypalon	Nylon 11 (Coating)	Solef	PFA	Polyester (GRP)	PTFE	*EPDM	Polyurethane	Preferred Lubricant No.	Alternative Lubricant No.
Trichloroethylene (dry)	C	B	B	B	B	x	B	A	A	B	A	B	A2	B	A	B	D	B	D	B	A	A	A	A	D	D	563	
Triethanolamine	B	B	B	A	A	X	B	A	X	B	A	A	A	D	A	X	A	D	A	A	A	A	X	A	A	D	147	735
Turpentine	B	B	B	A	A	X	B	B	A	A	A	B	B	B	A2	A	A	A	D	A	A	A	A	A	D	D	563	
Urea	C	C	X	B.	A	X	B	A	B6	C	A	X	A	B6	B	X	B	A	B	A	A	A	A	B	X	Refer to SAV		
Varnish (hot)	C	C	B	A	A	X	X	A	A	B	A	A	A	A	A	X	D	A	D	X	A	A	X	A	D	X	734	731
Vinegar	D	D	D	A	A	X	A	A	A	B	A	A	X	D	•B	A	C	B	D	B	A	A	A	A	A	X	2A	731
Vinyl chloride	C	C	C	B	B	X	X	A	A	C	A	A	A	X	A	X	X	A	D	A	A	A	X	A	B	X	563	
Water, distilled	B	B	B	A	A	A	A	A	A	A	A	A	A	B	A	A	A7	A	D	A	A	A	A7	A	A	A	2A	147
Water, fresh	B	B	B	A	A	A	A	A	A	A	A	A	A	A	B	A	A7	A	A	A	A	A	A7	A	A	A	731	734
Whiskey	D	D	D	A	A	D	B	A	B	C	A	A	A	B	B5	X	A	B	D	A	A	A	X	A	A	X	2A	
Wine	D	D	D	A	A	D	B	A	B	C	A	A	A	B	B	X	B	A	D	A	A	A	X	A	A	X	2A	
Xylene	B	B	B	A	A	X	A	A	A	A	A	A	A	A	A	A	D	B	D	A	A	A	A	A	D	D	563	
Zinc chloride	D	D	C	C5	B5	X	C	A2	A	C	A	B	B	C5	C5	A	B	A	A	A	A	A	A	A	A	A	731	734
Zinc nitrate	D	D	C	B	B	X	B	A	C	D	A	C	A	C	B	X	B	A	A	X	A	A	A	A	A	A	731	734
Zinc sulphate	B	B	B	A2	A2	X	A	A	B4	B	A	B	A	B4	C	B	A	A	A	A	A	A	A	A	A	A	731	734

2. Lubricant Information

Audco lubricants are formulated specially for use in Audco valves and no other types of lubricant should be used, nor should Audco valve lubricant be used for any purpose other than lubricating Audco plug valves except with our express recommendation.

MULTI-PURPOSE LUBRICANTS

STICK LUBRICANT	GUN LUBRICANT	TEMPERATURE RANGE AND COLOUR	RECOMMENDATIONS USE ON	DO NOT
731	731 Soft 0°F to 450°F	-15°C to 230°C	Suitable for most chemical plant services, White compressed air, water, aqueous solutions, dilute acids, all alkaline solutions, tars, bitumens.	Strong acid solutions. Petroleum products.
731 B	731 B Soft 0°F to 450°F	-15°C to 230°C	As above (used where a black lubricant is preferred.) Black	As above.
733	733 Soft 32°F to 480°F	0°C to 250°C	Butane, propane, gasoline, kerosene, oils, fueloils; most hydrocarbon solvents. Also suitable within a limited Cream' temperature range for strong sulphuric acids and hotgases.	Strong alkalis and high aromatic solvents.

The temperature range of each lubricant is given in these tables but the lubricant performance within the given temperature range may vary with the particular fluid being handled.
Please consult our catalogue Section No. 9 for full details of these lubricants.

SPECIALISED LUBRICANTS

STICK LUBRICANT	GUN LUBRICANT	TEMPERATURE RANGE AND COLOUR	RECOMMENDATIONS
2A	2A Soft	0°C to 200°C 32°F to 390°F White	Domestic water services, foodstuffs and pharmaceuticals.
147	147 Soft	-10°C to70°C 14°F to160°F White	Nitrating acids, sulphuric acid and other chemicals.
563	563 Soft	-10°Cto120°C 14°Fto250°F Cream	Chlorinated and aromatic hydrocarbon solvents.
734	734 Soft	0°C to 1 70°C 32°Fto340°F Cream	Water, high pressure hot water and steam.
735	735 Soft	0°Cto325°C 32°F to 620°F Black	Hot gases and high temperature applications (225°C maximum on hot air).
2515	2515 Soft	-40°C to 30°C -40°F to 90°F Cream	As 563.
2591	2591 Soft	0°Cto300°C 32°Fto570°F Cream	Petroleum based heat transfer oil. Fuel oil to 120°C.
2608	2608 Soft	15°Cto340°C 60°Fto640°F White	Hydrocarbon gases and vapours including high temperature cracking and reforming. Strong acids and alkalis to 150°C.

3. List of Relevant Standards

STANDARD	Description
IBR	The Indian Boiler Regulations - 1950
NACE MR 0175	Standard Material Requirements - Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment
ASTM A 105	Specification for Carbon Steel Forgings for Piping Applications
ASTM A 182	Specification for Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service
ASTM A 193	Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service.
ASTM A 194	Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service. or both
ASTM A 216	Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service.
ASTM A 217	Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure Containing Parts Suitable for High Temperature Service.
ASTM A 351	Specification for Steel Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure Containing Parts
ASTM A 352	Specification for Steel Castings, Ferritic and Martensitic, for Pressure Containing Parts Suitable for Low Temperature Service
ASTM A 439	Specification for Austenitic Ductile Iron Castings
ASTM A 479	Specification for Stainless Steel Bars and shapes for use in Boilers and other Pressure Vessels.
ASTM A 494	Specification for Castings. Nickel and Nickel Alloy
ASTM A 516	Specification for Pressure Vessel Plates, Carbon Steel for Moderate - and Lower Temperature Service
ASTM A 536	Specification for Ductile Iron Castings
API SPEC. Q1 (6th Edition)	Specification for Quality Programs for Petroleum and Natural Gas Industry
API SPEC 5L (41st Edition)	Line Pipe
API SPEC 6A (17th Edition)	Wellhead and Christmas Tree Equipment
API SPEC 6D (21st Edition)	Specification for Pipeline Valves (Gate, Plug, Ball and Check Valves)
API SPEC 6FA (2nd Edition)	Specification for Firetest for Valve
API STD 598 (7th Edition)	Valve Inspection and Testing

API STD 600 (10th Edition)	Steel Gate Valves - Flanged and Butt Welding Ends, Bolted and Pressure Seal Bonnets
API STD 602 (6th Edition)	Compact Steel Gate Valves - Flanged, Threaded, Welding and Extended Body Ends
API STD 607 (4th Edition)	Firetest for Soft Seated Quarterturn Valves
API STD 609 (5th Edition)	Lug and Wafer Type Butterfly Valves
ANSI/ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI/ASME B16.1	Cast Iron Pipe Flangs and Flanged Fittings
ASME B16.10	Face to Face and End to End Dimensions of Valves
ASME B16.11	Forged Fittings, Socket Welding and Threaded
ASME B16.25	Buttwelding Ends
ASME B16.34	Valves - Flanged Threaded and Welding End
ASME B16.47	Large Diameter Steel Flangs NPS 26 Through NPS 60
ASME B16.5	Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24
ANSI/AWWA C207	Steel Pipe Flanges for Waterworks Service-Sizes 4 in. Through 144 in. (100 mm through 3,600 mm)
ANSI/AWWA C504	Rubber Seated Butterfy Valves
MSS-SP-44	Steel Pipeline Flanges
ISO 9001 (2nd Edition)	Quality Systems Model for Quality Assurance in Design, Development, Production, Installation and Servicing
ISO 9002 (2nd Edition)	Quality System - Model for Quality Assurance in Production, Installation and Servicing
IS:210 Rev 4	Grey Iron Castings
BS:21	Specifiction for Pipe Threads for Tubes and Fitting where Pressure Tight Joints are made on the Threads
BS:1414	Specifiction for Steel Wedge Gate Valves (Flanged and Butt Welding Ends) for the Petroleum, Petrochemical and Allied Industries
BS:1868	Specifiction for Steel Check Valves (Flanged and Butt Welding Ends) for the Petroleum, Petrochemical and Allied Industries
BS:1873	Specification for Steel Globe and Globe Stop and Check Valves (Flanged & Butt Welding Ends) for the Petroleum, Petrochemical and Allied Industries
BS: 5155	Specification for Butterfly Valves
BS:5158	Specification for Cast Iron Plug Valves.
BS:5159	Specification for Cast Iron and Carbon Steel Ball Valves for General Purpose
BS:5351	Specification for Steel Ball Valves for the Petroleum Petrochemical and Allied Industries

BS:5352	Specification for Steel Wedge Gate, Globe and Check Valves - 50 mm and Smaller for the Petroleum Petrochemical and Allied Industries
BS:5353	Specification for Steel Plug Valve
BS:6755 Part 1	Testing of Valves - Part 1 - Specification for Production Pressure Testing Requirements
BS:6755 Part 2	Testing of Valves - Part 2 - Specification for Fire Type Testing Requirements
DIN 2501 Part 1	Flanges: Mating Dimensions
DIN 3230 Part 3	Technical Delivery Conditions for Valves - Compilation of Test Methods
ISS-Steel Products Manual	Iron & Steel Society - Steel Products Manual Stainless and Heat Resisting Steel. (Type 301, 302, 303, 304, 304 L, 308, 310, 316, 316 L, 321, 329, 410, 416, 420, 430, 431, 440 C)
ISS-Steel Bar Guidelines	ISS-Steel Bar Products Guidelines-BAR STEEL-Alloy, Carbon and Microally Steels Semifinished, Hot Rolled Bars, Cold Finished Bars, Hot Rolled Deformed and Plain Concrete Reinforcing Bars. (AISI/SAE 1010, 1020, 1040, 4130, 4130 H, 4140, 4140 H, 4145, 4145 H, 4340, 4340 H, 6150, 8620, 8260 H, 8630, 8630 H)
BS:10	Specification for Flangs and Bolting for Pipes, Valves and Fittings
DIN 2532	Cast Iron Flange - Normal Pressure 10
DIN 3230 Part 1	Technical Conditions of Delivery for Valves, General Requirements
DIN 3230 Part 2	Technical Conditions of Delivery for Valves, General Requirements
DIN 3230 Part 4	Technical Conditions of Delivery for Valves - Special Requirements and Tests for Valves for Water Services
DIN 3230 Part 5	Technical Delivey Conditions: Valves for Gas Installations and Gas Pipelines -Requirements and Testing
DIN 3230 Part 6	Technical Delivery Conditions for Valves, Requirements and Methods of Test for Valves for us with Flammable Liquids
ISO 5210/1	Part - turn Valve Actuator Attachment - Part 1: Flange Dimensions
ISO 5211/1	Part - turn Valve Actuator Attachment - Part 1: Flange Dimensions

1. Valve Trim Chart (Extract from - API 600)

Trim Number	Nominal Trim	Seat Surface Hardness (HB) Minimum (a)	Seat Surface Material Type (b)	Seat Surface Type Specification (Grade) Cast	Forged	Welded (m)	Stem/Bushing Material Type (b)	Typical Specifications Type	Stem Hardness (HB)	Backseat Bushing Hardness (HB)
1	F6	(c)	13 Cr.	ASTM A217(CA15)	ASTM A182(F6a)	AWS A5.9 ER410	13Cr	ASTM A276–T410 or T420	200min.,275 max.	250 min.
2	304	(d)	18Cr–8Ni	ASTM A351 (CF8)	ASTM A182 (F304)	AWS A5.9 ER308	I8Cr–8Ni	ASTMA276–T304	(d)	(d)
3	F310	(d)	25Cr–20Ni	•	ASTM A182 (F310)	AWS A5.9 ER310	25Cr–20Ni	ASTM A276–T310	(d)	(d)
4	Hard F6	750 (e)	Hard 13Cr	•	(f)	•	13Cr	ASTM A276–T410 or T420	200 min.275 max.	250 min.
5	Hardfaced	350 (e)	Co–Cr A (g)	•	•	AWS A5. 13 E or R CoCrA	13Cr	ASTM A276–T410 or T420	200 min.275 max.	250 min.
5A	Hardfaced	350 (e)	Ni–Cr	•	•	(h)	13Cr	ASTM A276–T410 or T420	200 min.275 max.	250 min.
6	F6 and	250 (i)	13Cr	ASTM A217(CA15)	ASTM A182(F6a)	AWS A5.9 ER410	13Cr	ASTM A276–T410 or T420	200 min. 275 max.	250 min.
	Cu–Ni	175(i)	Cu–Ni	•	(k)	•	•	•	•	•
7	F6 and	250(i)	13Cr	ASTM A217(CA15)	ASTM A182 (F6a)	AWS A5.9 ER410	13Cr	ASTM A276–T410 or T420	200 min.. 275 max.	250 min.
	Hard F6	750 (i)	Hard 13Cr	•	(f)	•	•	•	•	•
8	F6 and	250(i)	l3Cr	ASTMA217(CA15)	ASTM A182 (F6a)	AWS A5.9 ER410	13Cr	ASTM A276–T410 or T420	200 min..275 max.	250 min.
	Hardfaced	350(i)	Co–Cr A (g)	•	•	AWS A5.13 E or R CoCrA	•	•	•	•
8A	F6 and	250(i)	13Cr	ASTM A217(CA15)	ASTM A 182 (F6a)	AWS A5.9 ER410	13Cr	ASTM A276–T410 or T420	200 min.. 275 max	250 min.
	Hardfaced	350(i)	Ni–Cr	•	•	(h)	•	•	•	•
9	Moncl	(d)	Ni–Cu alloy	•	MFG. Standard	•	Ni–Cu alloy	MFG. Standard	(d)	(d)
10	316	(d)	I8Cr–8Ni	ASTM A351 (CF8M)	ASTM A 182 (F316)	AWS A5.9 ER316	18Cr–8Ni	ASTM A276–T316	(d)	(d)
11	Monel and	(d)	Ni–Cu alloy	•	MFG. Standard	•	Ni–Cu alloy	MFG Standard	(d)	(d)
	Hardfaced	350(i)	Trim 5 or 5A	•	•	See Trim 5 or 5A	•	•	•	•

12	316 and Hardfaced	(d) 350(i)	18Cr–8Ni Trim 5 or 5A	ASTM A351 (CF8M) •	ASTM A182 (F316) •	AWS A5.9 ER 316 See Trim 5 or 5A	18Cr–8Ni •	ASTM A276–T316 •	(d) •	(d) •
13	Alloy 20	(d)	19Cr–29Ni	ASTM A351 (CN7M)	ASTM B473	AWS A 5.9 ER320	19Cr–29Ni	ASTM B473	(d)	(d)
14	Alloy 20 and Hardfaced	(d) 350(i)	19Cr–29Ni Trim 5 or 5A	ASTM A351 (CN7M) •	ASTM B473 •	AWS A 5.9 ER320 See Trim 5 or 5A	19Cr–29Ni •	ASTM B473 •	(d) •	(d) •
15	Hardware	350(e)	Co–Cr A (g)	•	•	AWS A5.13 E or R CoCrA	18Cr–8Ni	ASTM A276–T304	(d)	(n)
16	Hardfaced	350(e)	Co–Cr A (g)	•	•	AWS A5.13 E or R CoCrA	18Cr–8Ni	ASTM A276–T316	(d)	(n)
17	Hardware	350(e)	Co–Cr A (g)	•	•	AWS A5.13 E or R CoCrA	18Cr–10Ni	ASTM A276–T347	(d)	(n)
18	Hardfaced	350(e)	Co–Cr A (g)	•	•	AWS A5.13 E or R CoCrA	19Cr–29Ni	ASTM B473	(d)	(n)

Note: Cr = Chromium; Ni = nicket; Co = cobalt; Cu= copper; • = Not applicable; (a) = HB (formerly BHN) is the symbol for the Brinell hardness per ASTM E 10: (b) = Free machining grades of 13 Cr are prohibited; (c) = Body and gate seat surfaces should be 250 HB minimum with a 50 HB minimum differential between the body and gate seat surfaces; (d) = Manufacturer's standard hardness; (c) = Differential hardness between the body and gate seat surfaces is not required; (f) = Case hardened by nitriding to a thickness of 0.13 millimeters (0.005 inch) minimum; (g) = This classification includes such trademarked materials as Stellite 6(TM). Stoody 6(TM), and Wallex 6(TM); (h) = Manufacturer's standard hardfacing with a maximum iron content of 25 percent; (i) = Hardness differential between the body and gate seat surfaces shall be the manufacturer's standard; (j) = Not used; (k) = Manufacturer's standard with 30 Ni minimum; (I) = Not used; (m) Typical backseat weld deposit material; (n) = Per manufacturer's standard if not hardfaced, 250 HB minimum if hardfaced.

Table 4 – Trim Numbers and Alternative Trim Numbers

Specified Trim Number	Alternative Trim Number
1	8 or 8 A
2	10
5A	5
6	8
8A	8

2. Pressure Temperature Ratings (Extract from ASME B16-34)

TABLE 2.1.1
RATINGS FOR GROUP 1.1 MATERIALS

A 105 (1)(6)	A 515 Gr. 70 (1)	A 675 Gr. 70 (1)(4)(5)	A 672 Gr. B70 (1)
A 216 Gr. WCB (1)	A 516 Gr. 70 (1)(2)	A 696 Gr. C	A 672 Gr. C70 (1)
A 350 Gr. LF2 (1)	A 537 Cl. 1 (3)		

NOTES:
(1) Upon prolonged exposure to temperatures above 800°F, the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800°F.
(2) Not to be used over 850°F.
(3) Not to be used over 700°F.
(4) Leaded grades shall not be used where welded or in any application above 500°F.
(5) For service temperatures above 850°F, it is recommended that killed steels containing not less than 0.10% residual silicon be used.
(6) Only killed steel shall be used above 850°F.

TABLE 2–1.1A STANDARD CLASS

Temperature		Working Pressures by Classes, psig							
°C	°F	150	300	400	600	900	1500	2500	4500
38	–20 to 100	285	740	990	1,480	2,220	3,705	6,170	11,110
93	200	260	675	900	1,350	2,025	3,375	5,625	10,120
149	300	230	655	875	1,315	1,970	3,280	5,470	9,845
204	400	200	635	845	1,270	1,900	3,170	5,280	9,505
260	500	170	600	800	1,200	1,795	2,995	4,990	8,980
316	600	140	550	730	1,095	1,640	2,735	4,560	8,210
343	650	125	535	715	1,075	1,610	2,685	4,475	8,055
371	700	110	535	710	1,065	1,600	2,665	4,440	7,990
399	750	95	505	670	1,010	1,510	2,520	4,200	7,560
427	800	80	410	550	825	1,235	2,060	3,430	6,170
454	850	65	270	355	535	805	1,340	2,230	4,010
482	900	50	170	230	345	515	860	1,430	2,570
510	950	35	105	140	205	310	515	860	1,545
538	1000	20	50	70	105	155	260	430	770

TABLE 2.1.1 (CONT'D)
RATINGS FOR GROUP 1.1 MATERIALS

A 105 (1)(6)	A 515 Gr. 70 (1)	A 675 Gr. 70 (1)(4)(5)	A 672 Gr. B70 (1)
A 216 Gr. WCB (1)	A 516 Gr. 70 (1)(2)	A 696 Gr. C	A 672 Gr. C70 (1)
A 350 Gr. LF2 (1)	A 537 Cl. 1 (3)		

NOTES:
(1) Upon prolonged exposure to temperatures above 800°F, the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800°F.
(2) Not to be used over 850°F.
(3) Not to be used over 700°F.
(4) Leaded grades shall not be used where welded or in any application above 500°F.
(5) For service temperatures above 850°F, it is recommended that killed steels containing not less than 0.10% residual silicon be used.
(6) Only killed steel shall be used above 850°F.

TABLE 2–1.1B SPECIAL CLASS

Temperature		Working Pressures by Classes, psig							
°C	°F	150	300	400	600	900	1500	2500	4500
38	–20 to 100	290	750	1,000	1,500	2,250	3,750	6,250	11,250
93	200	290	750	1,000	1,500	2,250	3,750	6,250	11,250
149	300	290	750	1,000	1,500	2,250	3,750	6,250	11,250
204	400	290	750	1,000	1,500	2,250	3,750	6,250	11,250
260	500	290	750	1,000	1,500	2,250	3,750	6,250	11,250
316	600	275	715	950	1,025	2,140	3,565	5,940	10,690
343	650	270	700	935	1000	2,100	3,495	5,825	10,485
371	700	265	695	925	1390	2,080	3,470	5,780	10,405
399	750	240	630	840	1260	1,890	3,150	5,250	9,450
427	800	200	515	685	1030	1,545	2,570	4,285	7,715
454	850	130	335	445	670	1,005	1,670	2,785	5,015
482	900	85	215	285	430	645	1,070	1,785	3,215
510	950	50	130	170	260	385	645	1,070	1,930
538	1000	25	65	85	130	195	320	535	965

TABLE 2–1.9
RATINGS FOR GROUP 1.9 MATERIALS

A 182 Gr. F11 Cl. 2 (1)(2)	A 217 Gr. WC6 (1)(3)	A 387 Gr. 11, Cl. 2 (2)	A 739 Gr. B11 (2)
A 182 Gr. F 12 Cl. 2 (1)(2)			

NOTES:
(1) Use normalized and tempered material only.
(2) Permissible, but not recommended for prolonged use above 1100°F.
(3) Not to be used over 1100°F.

TABLE 2–1.9A STANDARD CLASS

Temperature		Working Pressures by Classes, psig							
°C	°F	150	300	400	600	900	1500	2500	4500
38	–20 to 100	290	750	1,000	1,500	2,250	3,750	6,250	11,250
93	200	260	750	1,000	1,500	2,250	3,750	6,250	11,250
149	300	230	720	965	1,445	2,165	3,610	6,015	10,830
204	400	200	695	925	1,385	2,080	3,465	5,775	10,400
260	500	170	665	885	1,330	1,995	3,325	5,540	9,965
316	600	140	605	805	1,210	1,815	3,025	5,040	9,070
343	650	125	590	785	1,175	1,765	2,940	4,905	8,825
371	700	110	570	755	1,135	1,705	2,840	4,730	8,515
399	750	95	530	710	1,065	1,595	2,660	4,430	7,970
427	800	80	510	675	1,015	1,525	2,540	4,230	7,610
454	850	65	485	650	975	1,460	2,435	4,060	7,305
482	900	50	450	600	900	1,350	2,245	3,745	6,740
510	950	35	320	425	640	955	1,595	2,655	4,785
538	1000	20	215	290	430	650	1,080	1,800	3,240
566	1050	20(1)	145	190	290	430	720	1,200	2,160
593	1100	20(1)	95	130	190	290	480	800	1,440
621	1150	20(1)	60	80	125	185	310	515	925
649	1200	15(1)	40	50	75	115	190	315	565

Note: (1) For welding end valves only. Flanged end ratings terminate at 1000°F.

TABLE 2–1.9 (CONT'D)

RATINGS FOR GROUP 1.9 MATERIALS

A 182 Gr. F11 Cl. 2 (1)(2)	A 217 Gr. WC6 (1)(3)	A 387 Gr. 11, Cl. 2 (2)	A 739 Gr. B11 (2)
A 182 Gr. F 12 Cl. 2 (1)(2)			

NOTES:

(1) Use normalized and tempered material only.

(2) Permissible, but not recommended for prolonged use above 1100°F.

(3) Not to be used over 1100°F.

TABLE 2–1.9B SPECIAL CLASS

Temperature		Working Pressures by Classes, psig							
°C	°F	150	300	400	600	900	1500	2500	4500
38	–20 to 100	290	750	1,000	1,500	2,250	3,750	6,250	11,250
93	200	290	750	1,000	1,500	2,250	3,750	6,250	11,250
149	300	290	750	1,000	1,500	2,250	3,750	6,250	11,250
204	400	290	750	1,000	1,500	2,250	3,750	6,250	11,250
260	500	290	750	1,000	1,500	2,250	3,750	6,250	11,250
316	600	290	750	1,000	1,500	2,250	3,750	6,250	11,250
343	650	290	750	1,000	1,500	2,250	3,750	6,250	11,250
371	700	280	735	980	1,465	2,200	3,665	6,110	10,995
399	750	280	730	970	1,460	2,185	3,645	6,070	10,930
427	800	275	720	960	1,440	2,160	3,600	6,000	10,800
454	850	260	680	905	1,355	2,030	3,385	5,645	10,160
482	900	225	585	785	1,175	1,760	2,935	4,895	8,805
510	950	155	400	530	795	1,195	1,995	3,320	5,980
538	1000	105	270	360	540	810	1,350	2,250	4,050
566	1050	70	180	240	360	540	900	1,500	2,700
593	1100	45	120	160	240	360	600	1,000	1,800
621	1150	30	75	105	155	230	385	645	1,155
649	1200	20	45	65	95	140	235	395	705

TABLE 2-1.10

RATINGS FOR GROUP 1.10 MATERIALS

A 182 Gr. F22.CI. 3 (2)	A 217 Gr. WC9 (1)(3)	A 387 Gr. 22, CI. 2 (2)	A 739 Gr. B22 (2)

NOTES:

(1) Use normalized and tempered material only.

(2) Permissible, but not recommended for prolonged use above 1100°F.

(3) Not to be used over 1100°F.

TABLE 2–1.10A STANDARD CLASS

Temperature		Working Pressures by Classes, psig							
°C	°F	150	300	400	600	900	1500	2500	4500
38	–20 to 100	290	750	1,000	1,500	2,250	3,750	6,250	11,250
93	200	260	750	1,000	1,500	2,250	3,750	6,250	11,250
149	300	230	730	970	1,455	2,185	3,640	6,070	10,925
204	400	200	705	940	1,410	2,115	3,530	5,880	10,585
260	500	170	665	885	1,330	1,995	3,325	5,540	9,965
316	600	140	605	805	1,210	1,815	3,025	5,040	9,070
343	650	125	590	785	1,175	1,765	2,940	4,905	8,825
371	700	110	570	755	1,135	1,705	2,840	4,730	8,515
399	750	95	530	710	1,065	1,595	2,660	4,430	7,970
427	800	80	510	675	1,015	1,525	2,540	4,230	7,610
454	850	65	485	650	975	1,460	2,435	4,060	7,305
482	900	50	450	600	900	1,350	2,245	3,745	6,740
510	950	35	375	505	755	1,130	1,885	3,145	5,665
538	1000	20	260	345	520	780	1,305	2,170	3,910
566	1050	20(1)	175	235	350	525	875	1.455	2,625
593	1100	20(1)	110	145	220	330	550	915	1,645
621	1150	20(1)	70	90	135	205	345	570	1,030
649	1200	20(1)	40	55	80	125	205	345	615

Note: (1) For welding end valves only. Flanged end ratings terminate at 1000°F.

TABLE 2-1.10 (CONT'D)

RATINGS FOR GROUP 1.10 MATERIALS

A 182 Gr. F22 CI. 3 (2)	A 217 Gr. WC9 (1)(3)	A 387 Gr. 22, CI. 2 (2)	A 739 Gr. B22 (2)

NOTES:

(1) Use normalized and tempered material only.

(2) Permissible, but not recommended for prolonged use above 1100°F.

(3) Not to be used over 1100°F.

TABLE 2-1.10B SPECIAL CLASS

Temperature		Working Pressures by Classes, psig							
°C	**°F**	**150**	**300**	**400**	**600**	**900**	**1500**	**2500**	**4500**
38	-20 to 100	290	750	1,000	1,500	2,250	3,750	6,250	11,250
93	200	290	750	1,000	1,500	2,250	3,750	6,250	11,250
149	300	285	740	990	1,485	2,225	3,705	6,180	11,120
204	400	280	725	965	1,450	2,175	3,620	6,035	10,865
260	500	275	720	960	1,440	2,160	3,600	6,000	10,800
316	600	275	720	960	1,440	2,160	3,600	6,000	10,800
343	650	275	715	955	1,430	2,145	3,580	5,965	10,735
371	700	275	710	955	1,425	2,135	3,555	5,930	10,670
399	750	265	690	920	1,380	2,070	3,450	5,750	10,350
427	800	260	675	895	1,345	2,020	3,365	5,605	10,095
454	850	245	645	855	1,285	1,930	3,215	5,355	9,645
482	900	230	600	800	1,200	1,800	3,000	5,000	9,000
510	950	180	470	630	945	1,415	2,355	3,930	7,070
538	1000	125	325	435	650	975	1,630	2,715	4,885
566	1050	85	220	290	435	655	1,095	1,820	3,280
593	1100	55	135	185	275	410	685	1,145	2,055
621	1150	35	85	115	170	255	430	715	1,285
649	1200	25	50	70	105	155	255	430	770

TABLE 2–2.1

RATINGS FOR GROUP 2.1 MATERIALS

A 182 Gr. F304 (1)	A 312 Gr. TP304 (1)	A 358 Gr. 304 (1)	A 430 Gr. FP304H
A 182 Gr. F304H	A 312 Gr. TP304H	A 376 Gr. TP304 (1)	A 479 Gr. 304 (1)
A 240 Gr. 304 (1)	A 351 Gr. CF3 (2)	A 376 Gr. TP304H	A 479 Gr. 304H
A 240 Gr. 304H	A 351 Gr. CF8 (1)	A 430 Gr. FP304 (1)	

NOTES:

(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.

(2) Not to be used over 800°F.

TABLE 2–2.1A STANDARD CLASS

Temperature		Working Pressures by Classes, psig							
°C	**°F**	**150**	**300**	**400**	**600**	**900**	**1500**	**2500**	**4500**
38	-20 to 100	275	720	960	1,440	2,160	3,600	6,000	10,800
93	200	230	600	800	1,200	1,800	3,000	5,000	9,000
149	300	205	540	720	1,080	1,620	2,700	4,500	8,100
204	400	190	495	660	995	1,490	2,485	4,140	7,450
260	500	170	465	620	930	1,395	2,330	3,880	6,985
316	600	140	435	580	875	1,310	2,185	3,640	6,550
343	650	125	430	575	860	1,290	2,150	3,580	6,445
371	700	110	425	565	850	1,275	2,125	3,540	6,370
399	750	95	415	555	830	1,245	2,075	3,460	6,230
427	800	80	405	540	805	1,210	2.015	3,360	6,050
454	850	65	395	530	790	1,190	1,980	3,300	5,940
482	900	50	390	520	780	1,165	1,945	3,240	5,830
510	950	35	380	510	765	1,145	1,910	3,180	5,725
538	1000	20	320	430	640	965	1,605	2,675	4,815
566	1050	20(1)		410	615	925	1,545	2,570	4,630
593	1100	20(1)	255	345	515	770	1,285	2,145	3,855
621	1150	20(1)	200	265	400	595	995	1,655	2,985
649	1200	20(1)	155	205	310	465	770	1,285	2,315
677	1250	20(1)	115	150	225	340	565	945	1,695
704	1300	20(1)	85	115	170	255	430	715	1.285
732	1350	20(1)	60	80	125	185	310	515	925
760	1400	20(1)	50	65	95	145	240	400	720
788	1450	15(1)	35	45	70	105	170	285	515
816	1500	10(1)	25	35	55	80	135	230	410

NOTE: (1) For welding end valves only. Flanged end ratings terminate at 1000°F.

TABLE 2-2.1 (CONT'D)
RATINGS FOR GROUP 2.1 MATERIALS

A 182 Gr. F304 (1)	A 312 Gr. TP304 (1)	A 358 Gr. 304 (1)	A 430 Gr. FP304H
A 182 Gr. F304H	A 312 Gr. TP304H	A 376 Gr. TP304 (1)	A 479 Gr. 304 (1)
A 240 Gr. F304 (1)	A 351 Gr. CF3 (2)	A 376 Gr. TP304H	A 479 Gr. 304H
A 240 Gr. F304H	A 351 Gr. CF8 (1)	A 430 Gr. FP304 (1)	

NOTES:
(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.
(2) Not to be used over 800°F.

TABLE 2-2.1B SPECIAL CLASS

Temperature		Working Pressures by Classes, psig							
°C	°F	150	300	400	600	900	1500	2500	4500
38	-20 to 100	290	750	1,000	1,500	2,250	3,750	6,250	11,250
93	200	255	670	890	1,355	2,005	3,345	5,570	10,030
149	300	230	600	800	1,200	1,800	3,000	5,000	9,000
204	400	210	555	735	1,105	1,660	2,765	4,605	8,295
260	500	200	520	690	1,035	1,555	2,595	4,320	7,780
316	600	185	490	650	975	1,465	2,440	4,065	7,315
343	650	185	480	640	960	1,440	2,395	3,995	7,190
371	700	180	470	630	945	1,415	2,355	3,930	7,070
399	750	175	465	615	925	1,390	2,315	3,855	6,945
427	800	175	450	600	900	1,350	2,250	3,750	6,750
454	850	170	440	590	885	1,325	2,205	3,680	6,620
482	900	165	435	575	865	1,300	2,165	3,605	6,495
510	950	165	425	565	850	1,275	2,120	3,535	6,365
538	1000	155	405	545	815	1,220	2,035	3,395	6,105
566	1050	150	385	515	770	1,115	1,930	3,215	5,785
593	1100	125	320	430	645	965	1,605	2,680	4,820
621	1150	95	250	330	495	745	1,245	2,070	3,730
649	1200	75	195	255	385	580	965	1,605	2,895
677	1250	55	140	190	285	425	705	1,180	2,120
704	1300	40	105	145	215	320	535	895	1,605
732	1350	30	75	105	155	230	385	645	1,155
760	1400	25	60	80	120	180	300	500	900
788	1450	15	45	55	85	130	215	355	645
816	1500	15	35	45	70	105	170	285	515

TABLE 2–2.2
RATINGS FOR GROUP 2.2 MATERIALS

A 182 Gr. F316 (1)	A 312 Gr. TP316 (1)	A 351 Gr. CF8A (2)	A 430 Gr. FP316 (1)
A 182 Gr. F316H	A 312 Gr. TP316H	A 351 Gr. CF8H (1)	A 430 Gr. FP316H
A 240 Gr. F316 (1)	A 312 Gr. TP317 (1)	A 358 Gr. 316 (1)	A 479 Gr. 316 (1)
A 240 Gr. F316H	A 351 Gr. CF3A (2)	A 376 Gr. TP316 (1)	A 479 Gr. 316H
A 240 Gr. F317 (1)	A 351 Gr. CF3H (3)	A 376 Gr. TP316H	A 351 Gr. CG8H (4)

NOTES:
(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.
(2) Not to be used over 650°F
(3) Not to be used over 850°F
(4) Not to be used over 1000°F

TABLE 2–2.1A STANDARD CLASS

Temperature		Working Pressures by Classes, psig							
°C	°F	150	300	400	600	900	1500	2500	4500
38	-20 to 100	275	720	960	1,440	2,160	3,600	6,000	10,800
93	200	235	620	825	1,240	1,860	3,095	5,160	9,290
149	300	215	560	745	1,120	1,680	2,795	4,660	8,390
204	400	195	515	685	1,025	1,540	2,570	4,280	7.705
260	500	170	480	635	955	1,435	2,390	3,980	7,165
316	600	140	450	600	900	1,355	2,255	3,760	6.770
343	650	125	445	590	890	1,330	2,220	3,700	6,660
371	700	110	430	580	870	1,305	2,170	3,620	6,515
399	750	95	425	570	855	1,280	2,135	3,560	6,410
427	800	80	420	565	845	1,265	2,110	3,520	6,335
454	850	65	420	555	835	1,255	2,090	3,480	6,265
482	900	50	415	555	830	1,245	2,075	3.460	6,230
510	950	35	385	515	775	1,160	1,930	3.220	5,795
538	1000	20	350	465	700	1,050	1,750	2,915	5,245
566	1050	20(1)	345	460	685	1,030	1,720	2,865	5,155
593	1100	20(1)	305	405	610	915	1,525	2.545	4,575
621	1150	20(1)	235	315	475	710	1,185	1,970	3,550
641	1200	20(1)	185	245	370	555	925	1,545	2,775
677	1250	20(1)	145	195	295	440	735	1,230	2,210
704	1300	20(1)	115	155	235	350	585	970	1,750
732	1350	20(1)	95	130	190	290	480	800	1,440
760	1400	20(1)	75	100	150	225	380	630	1,130
788	1450	20(1)	60	80	115	175	290	485	875
816	1500	20(1)	40	55	85	125	205	345	620

NOTE: (1) For welding end valves only. Flanged end ratings terminate at 1000°F.

3. Flange Dimensions & Drilling Data

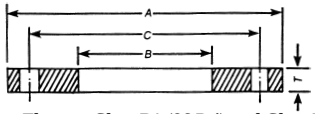


Table 1 AWWA Standard Steel Ring Flanges, Class B* (86 Psi) and Class D† (175-150 psi)

Nominal Pipe Size *in.*	OD of Flange (A) *in.*	ID of Flange(B‡) *in.*	Number of Bolts	Diam. of Bolt Circle(C) *in.*	Diam. of Bolts§ *in*		Thickness of Flange *in*	
					Class B	Class D	Class B *(T)*	Class D *(T)*
4	9.00	4.57	8	7.50	0.625	0.625	0.625	0.625
5	10.00	5.66	8	8.50	0.625	0.750	0.625	0.625
6	11.00	6.72	8	9.50	0.625	0.750	0.688	0.688
8	13.50	8.75	8	11.75	0.625	0.750	0.688	0.688
10	16.00	10.88	12	14.25	0.625	0.875	0.688	0.688
12	19.00	12.88	12	17.00	0.625	0.875	0.688	0.812
14	21.00	14.19	12	18.75	0.750	1.000	0.688	0.938
16	23.50	16.19	16	21.25	0.750	1.000	0.688	1.000
18	25.00	18.19	16	22.75	0.750	1.125	0.688	1.062
20	27.50	20.19	20	25.00	0.750	1.125	0.688	1.125
22	29.50	22.19	20	27.25	0.750	1.250	0.750	1.188
24	32.00	24.19	20	29.50	0.750	1.250	0.750	1.250
26	34.25		24	31.75	0.750	1.250	0.812	1.312
28	36.50		28	34.00	0.750	1.250	0.875	1.312
30	38.75		28	36.00	0.875	1.250	0.875	1.375
32	41.75		28	38.50	0.875	1.500	0.938	1.500
34	43.75		32	40.50	0.875	1.500	0.938	1.500
36	46.00		32	42.75	0.875	1.500	1.000	1.625
38	48.75		32	45.25	0.875	1.500	1.000	1.625
40	50.75		36	47.25	0.875	1.500	1.000	1.625
42	53.00		36	49.50	1.000	1.500	1.125	1.750
44	55.25		40	51.75	1.000	1.500	1.125	1.750
46	57.25		40	53.75	1.000	1.500	1.125	1.750
48	59.50		44	56.00	1.000	1.500	1.250	1.750
50	61.75		44	58.25	1.125	1.750	1.250	2.000
52	64.00		44	60.50	1.125	1.750	1.250	2.000
54	66.25		44	62.75	1.250	1.750	1.375	2.125
60	73.00		52	69.25	1.250	1.750	1.500	2.250
66	80.00		52	76.00	1.250	1.750	1.625	2.500
72	86.50		60	82.50	1.250	1.750	1.750	2.625
78	93.00		64	89.00	1.500	2.000	2.000	2.750
84	99.75		64	95.50	1.500	2.000	2.000	2.750
90	106.50		68	102.00	1.750	2.250	2.250	3.000
96	113.25		68	108.50	1.750	2.250	2.250	3.000
102	120.00		72	114.50	2.000	2.500	2.500	3.250
108	126.75		72	120.75	2.000	2.500	2.500	3.250
114	133.50		76	126.75	2.250	2.750	2.750	3.500
120	140.25		76	132.75	2.250	2.750	2.750	3.500
126	147.00		80	139.25	2.500	3.000	3.000	3.750
132	153.75		80	145.75	2.500	3.000	3.000	3.750
138	160.50		84	152.00	2.750	3.250	3.250	4.000
144	167.25		84	158.25	2.750	3.250	3.250	4.000

* Pressure rating at atmospheric temperature is 86 psi. These flanges have the same OD, bolt circle diameter, and number of bolts as ANSI B16.1 (125-psi cast-iron pipe flanges and flanges fittings) but use smaller bolts. In sizes 48 in. and smaller they have the same size bolts, and in sizes greater than 48 in they use bolts larger than specified by the 25-Psi standard. They also have the same OD, bolt circle diameter, and number of bolts as ANSI. Pressure rating at atmospheric temperature: size 4-12in. Inclusive, 175 psi; sizes larger than 12 ., 150 psi . These flanges have the same diameter and drilling as class 125 cast-iron FLANGES (ANSI B16.1) In sizes 24 in. and smaller, they also match ANSI B16.5 150 psi standard for steel flanges.

‡ The purchaser should specify the ID of the flange, dimension B, for nominal pipe sizes 26 in. and larger.

§ Bolt holes shall be drilled in. larger in diameter than the nominal diameter of the bolt as stated in Sec.3.3.

† B16. 1/125 - (psi cast pipe flanges & flang fittings)

TABLE 2-2.2 (CONT'D)
RATINGS FOR GROUP 2.2 MATERIALS

A 182 Gr. F316 (1)	A 312 Gr. TP316 (1)	A 351 Gr. CF8A (2)	A 430 Gr. FP316 (1)
A 182 Gr. F316H	A 312 Gr. TP316H	A 351 Gr. CF8H (1)	A 430 Gr. FP316H
A 240 Gr. F316 (1)	A 312 Gr. TP317 (1)	A 358 Gr. 316 (1)	A 479 Gr. 316 (1)
A 240 Gr. F316H	A 351 Gr. CF3A (2)	A 376 Gr. TP316 (1)	A 479 Gr. 316H
A 240 Gr. F317 (1)	A 351 Gr. CF3H (3)	A 376 Gr. TP316H	A 351 Gr. CG8H (4)

NOTES:
(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.
(2) Not to be used over 650°F
(3) Not to be used over 850°F
(4) Not to be used over 1000°F

TABLE 2-2.2B SPECIAL CLASS

Temperature		Working Pressures by Classes, psig							
°C	**°F**	**150**	**300**	**400**	**600**	**900**	**1500**	**2500**	**4500**
38	-20 to 100	290	750	1,000	1,500	2,250	3,750	6,250	11,250
93	200	265	690	920	1,380	2,070	3,450	5,750	10,350
149	300	240	625	830	1,250	1,870	3,120	5,200	9,360
204	400	220	570	760	1,140	1,710	2,850	4,750	8,550
260	500	205	530	710	1,065	1,595	2,655	4,430	7,970
316	600	195	505	670	1,005	1,510	2,520	4,195	7,555
343	650	190	495	655	985	1,480	2,465	4,105	7,395
371	700	185	485	645	970	1,455	2,420	4,035	7,265
399	750	180	475	635	950	1,425	2,380	3,965	7,135
427	800	180	470	630	945	1,415	2,355	3,930	7,070
454	850	180	465	620	930	1,400	2,330	3,885	6,990
482	900	175	465	615	925	1,390	2,315	3,855	6,945
510	950	175	460	610	915	1,375	2,290	3,815	6,870
538	1000	160	420	560	840	1,260	2,105	3,505	6,310
566	1050	160	420	560	840	1,260	2,105	3,505	6,310
593	1100	145	380	510	765	1,145	1,905	3,180	5,720
621	1150	115	295	395	590	885	1,480	2,465	4,435
649	1200	90	230	310	465	695	1,155	1,930	3,470
677	1250	70	185	245	370	555	920	1,535	2,765
704	1300	55	145	195	290	435	730	1,215	2,185
732	1350	45	120	160	240	360	600	1,000	1,800
760	1400	35	95	125	190	285	470	785	1,415
788	1450	30	75	100	145	200	365	610	1,095
816	1500	20	50	70	105	155	260	430	770

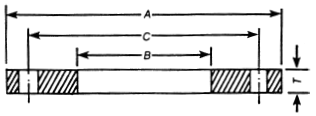


Table 2 AWWA Standard Steel Ring Flanges, Class E* (275 Psi)

Nominal Pipe Size *in.*	OD of Flange (A) *in.*	ID of Flange(B+) *in.*	Number of Bolts	Diam. Of Bolt Circle(C) *in.*	Diam. of Bolts ‡ *in*	Thickness of Flange(T) *in.*
4	9.00	4.57	8	7.50	0.625	1.125
5	10.00	5.66	8	8.50	0.750	1.188
6	11.00	6.72	8	9.50	0.750	1.313
8	13.50	8.72	8	11.75	0.750	1.500
10	16.00	10.88	12	14.25	0.875	1.563
12	19.00	12.88	12	17.00	0.875	1.750
14	21.00	14.19	12	18.75	1.000	1.875
16	23.50	16.19	16	21.25	1.000	2.000
18	25.00	18.19	16	22.75	1.125	2.125
20	27.50	20.19	20	25.00	1.125	2.375
22	29.50	22.19	20	27.25	1.250	2.500
24	32.00	24.19	20	29.50	1.250	2.625
26	34.25		24	31.75	1.250	2.750
28	36.50		28	34.00	1.250	2.750
30	38.75		28	36.00	1.250	2.875
32	41.75		28	38.50	1.500	3.000
34	43.75		32	40.50	1.500	3.000
36	46.00		32	42.75	1.500	3.125
38	48.75		32	45.25	1.500	3.125
40	50.75		36	47.25	1.500	3.250
42	53.00		36	49.50	1.500	3.375
44	55.25		40	51.75	1.500	3.375
46	57.25		40	53.75	1.500	3.438
48	59.50		44	56.00	1.500	3.500
50	61.75		44	58.25	1.750	3.500
52	64.00		44	60.50	1.750	3.625
54	66.25		44	62.75	1.750	3.750
60	73.00		52	69.25	1.750	3.875
66	80.00		52	76.00	1.750	4.250
72	86.50		60	82.50	1.750	4.375
78	93.00		64	89.00	2.000	4.750
84	99.75		64	95.50	2.000	4.750
90	106.50		68	102.00	2.250	5.125
96	113.25		68	108.50	2.250	5.125
102	120.00		72	114.50	2.500	5.500
108	126.75		72	120.75	2.500	5.500
114	133.50		76	126.75	2.750	5.875
120	140.25		76	132.75	2.750	5.875
126	147.00		80	139.25	3.000	6.250
132	153.75		80	145.75	3.000	6.250
138	160.50		84	152.00	3.250	6.750
144	167.25		84	158.25	3.250	6.750

*Pressure rating at atmospheric temperature is 275 psi. These flanges have the same diameter and drilling as ANSI B16.1, class 155 Cast Iron flanges. In size 24" and smaller they also match. ANSI 150-psi standard for steel flanges.

+ the purchaser should specify the ID of the flanges, dimension B.for nominal pipe sizes 26 in. and larger. It is recommended that this dimension be 3/10- in. larger in diameter than the nominal OD of the pipe.

‡Bolt holes shall be drilled 1/8 -in. larger in diameter than the nominal diameter of the bolt as stated in Sec.3.3

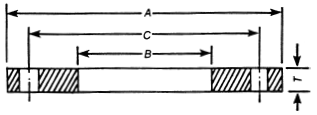


Table 3 AWWA Standard Steel Ring Flanges, Class F* (300 Psi)

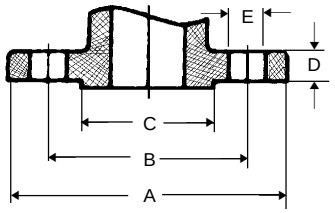
Nominal Pipe Size *in.*	OD of Flange (A) *in.*	ID of Flange(B+) *in.*	Number of Bolts	Diam. Of Bolt Circle(C) *in.*	Diam. of Bolts ‡ *in*	Thickness of Flange(T) *in.*
4	10.00	4.57	8	7.88	0.750	1.125
5	11.00	5.66	8	9.25	0.750	1.188
6	12.50	6.72	12	10.62	0.750	1.375
8	15.00	8.72	12	13.00	0.875	1.563
10	17.50	10.88	16	15.25	1.000	1.625
12	20.50	12.88	16	17.75	1.125	1.825
14	23.00	14.19	20	20.25	1.125	1.938
16	25.50	16.19	20	22.50	1.250	2.063
18	28.00	18.19	24	24.75	1.250	2.188
20	30.50	20.19	24	27.00	1.250	2.438
24	36.00	24.19	24	32.00	1.500	2.688
30	43.00		28	39.25	1.750	2.938
36	50.00		32	46.00	2.000	3.188
42	57.00		36	52.75	2.000	3.438
48	65.00		40	60.75	2.000	3.563

*Pressure rating at atmospheric temjperature is 300 psi. These flanges have the same diameter and drilling as ANSI B16.1,class 250 cast-iron pipe and flanged fittings

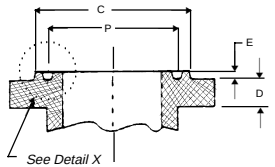
+ The purchaser should specify the ID of the flange, dimension B, for nominal pipe sizes 26 in. and larger. It is recommended that this dimension be 3/16-in. larger in diameter than the nominal OD of the pipe.

‡ Bolt holes shall be drilled 1/8-in. larger in diameter than the nominal diamete of the bolt as stated in Sec. 3.3.

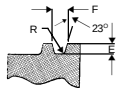
End Flange Dimension - ASME B16.5, 1996



Flange - Raised Face



Flange - Ring Type



Detail X

Valve Size	ASME Clase 150 Raised Face in mm							ASME Clase 150 Raised Face in mm						
	AØ	BØ	CØ	D	EØ	Bolt No.	Bolt Dia	AØ	BØ	CØ	D	EØ	Bolt No.	Bolt Dia
50(2")	152	120	92	19.1 (15.9)	19	4	5/8"	165	127	92	22.3	19	8	5/8"
65(21/2")	178	139	105	22.3 (17.5)	19	4	5/8"	190	149	105	25.4	22	8	3/4"
80(3")	190	152	127	23.9 (19.1)	19	4	5/8"	210	168	127	28.6	22	8	3/4"
100(4")	229	190	157	23.9	19	8	5/8"	254	200	157	31.8	22	8	3/4"
125(5")	254	216	186	23.9	22	8	3/4"	279	235	186	35.0	22	8	3/4"
150 (6")	279	241	216	25.4	22	8	3/4"	318	270	216	36.6	22	12	3/4"
200 (8")	343	298	270	28.6	22	8	3/4"	381	330	270	41.3	25	12	7/8"
250 (10")	406	362	324	30.2	25	12	7/8"	444	387	324	47.7	29	16	1
300 (12")	483	432	381	31.8	25	12	7/8"	521	451	381	50.8	32	16	1 1/8"
350 (14")	533	476	413	35.0	29	12	1"	584	514	413	54.0	32	20	1 1/8"
400 (16")	597	539	470	36.6	29	16	1"	648	571	470	57.2	35	20	1 1/4"
450 (18")	635	578	533	39.7	32	16	1 1/8"	711	628	533	60.4	35	24	1 1/4"
500 (20")	698	635	584	42.9	32	20	1 1/8"	775	686	584	63.5	35	24	1 1/4"
600 (24")	813	749	692	47.7	35	20	1 1/4"	914	813	692	69.9	41	24	1 1/2"

Height of raised face is 1.6mm (0.06") each

Large-Size Pipe Flange Drilling Dimensions as per ASME 16.47, 1996 series A (MSS SP44)									Large-size Pipe Flange Drilling dimensions as per ASME 16.47,1996 Seies B (API 605)								
ASME Class	Valve Size	AØ	BØ	CØ	D	EØ	Bolt No.	Bolt Dia	ASME Class	Valve Size	AØ	BØ	CØ	D	EØ	Bolt No.	Bolt Dia
	700 (28")	927	864	800	71	35	28	1 3/8"		700 (28")	837	795	762	48	22	40	3/4"
	750 (30")	984	914	857	75	35	28	1 3/8"		750 (30")	887	846	813	51	22	44	3/4"
CL. 150	850 (34")	1111	1029	965	83	41	32	1 1/2"	CL. 150	850 (34")	1005	957	921	57	25	40	7/8"
	900 (36")	1166	1086	1022	90	41	32	1 1/2"		900 (36")	1057	1010	972	59	25	44	7/8"
	1050 (42")	1346	1257	1194	97	41	36	1 1/2"		1050 (42")	1226	1171	1130	68	28	48	1"
	1200 (48")	1511	1422	1359	108	41	44	1 1/2"		1200 (48")	1392	1335	1289	75	28	44	1 1/8"
CL. 300	750 (30)	1092	997	857	95	48	28	1 3/4"	CL.300	750 (30")	991	921	845	94	41	36	1 3/8"

Height of raised face is 1.6mm (0.06") each

Height of raised face is 1.6mm (0.06") each

ASME Class 600 Raised Face (in mm)								ASME Class 600 Ring Type (in mm)								
Valve Size	AØ	BØ	CØ	D	EØ	Bolt No.	Bolt Dia	Valve Size	AØ	BØ	CØ	D	Grv.No	Pilch Ø - P	Depth E	Width F	Bottam Red.R
50 (2")	165	127	92	25.4	19	8	5/8"	50 (2")	165	127	108	25.4	R23	83	8	12	0.76
65 (21/2)	190	149	105	28.6	22	8	3/4"	65 (21/2")	190	149	127	28.6	R26	100	8	12	0.76
80 (3")	210	168	127	31.8	22	8	3/4"	80 (3")	210	168	146	31.8	R31	124	8	12	0.76
100 (4")	273	216	157	38.1	25	8	7/8"	100 (4")	273	216	171	38.1	R37	150	8.4	8.7	0.76
125 (5")	330	266	186	44.5	29	8	1"	125 (5")	330	266	209	44.5	R41	181	8	12	0.76
150 (6")	356	292	216	47.7	29	12	1"	150 (6")	356	292	241	47.7	R45	211	8	12	0.76
200 (8")	419	349	270	55.6	32	12	1 1/8"	200 (8")	419	349	302	55.6	R49	270	8	12	0.76
250 (10")	508	432	324	63.5	35	16	1 1/4"	250 (10")	508	432	356	63.5	R53	324	8	12	0.76
300 (12")	559	489	381	66.7	35	20	1 1/4"	300 (12")	559	489	413	66.7	R57	381	8	12	0.76
350 (14")	603	527	413	69.9	38	20	1 3/8"	350 (14")	603	527	457	69.9	R61	419	8	12	0.76
400 (16")	686	603	470	76.2	41	20	1 1/2"	400 (16")	686	603	508	76.2	R65	470	8	12	0.76
450 (18")	743	654	533	82.6	45	20	1 5/8"	450 (18")	743	654	575	82.6	R69	533	8	12	0.76
500 (20")	813	724	584	88.9	45	24	1 5/8"	500 (20")	813	724	635	88.9	R73	584	9.5	13.5	1.52
600 (24")	940	838	692	102.0	51	24	1 7/8"	600 (24")	940	838	749	101.6	R77	692	11.1	16.6	1.52

Height of raised face is 1.6mm (0.06") each

Height of raised face is 1.6mm (0.06") each Grv.-Groove

ASME Class 900 Raised Face (in mm)								ASME Class 900 Ring Type (in mm)								
Valve Size	AØ	BØ	CØ	D	EØ	Bolt No.	Bolt Dia	Valve Size	AØ	BØ	CØ	D	Grv.No	Pilch Ø - P	Depth E	Width F	Bottam Red .R
50(2")	216	165	92	38.1	25.4	8	7/8"	50 (2")	216	185	124	38.1	R24	95	8	12	0.76
65 (21/2")	244	191	105	41.1	28.4	8	1"	65 (2 1/2")	244	191	137	41.1	R27	108	8	12	0.76
80 (3")	241	191	127	38.1	25.4	8	7/8"	80 (3")	241	191	146	38.1	R31	124	8	12	0.76
100 (4")	292	235	157	44.5	31.8	8	1 1/8"	100 (4")	292	235	171	44.5	R37	149	8	12	0.76
125 (5")	349	279	186	50.8	35.1	8	1 1/4"	125 (5")	349	279	209	50.8	R41	181	8	12	0.76
150 (6")	381	318	216	55.6	31.8	12	1 1/8"	150 (6")	381	318	241	55.8	R45	211	8	12	0.76
200 (8")	470	394	270	63.5	38.1	12	1 3/8"	200 (8")	470	394	308	63.6	R49	270	8	12	0.76
250 (10")	546	470	324	69.9	38.1	16	1 3/8"	250 (10")	546	470	362	69.9	R53	324	8	12	0.76
300 (12")	610	533	381	79.2	38.1	20	1 3/8"	300 (12")	610	533	419	79.2	R57	381	8	12	0.76
350 (14")	641	559	413	85.9	41.1	20	1 1/2"	350 (14")	641	559	467	85.9	R62	419	11.1	16.6	1.52
400 (16")	705	616	470	88.9	44.5	20	1 5/8"	400 (16")	705	616	554	88.9	R66	470	11.1	16.6	1.52
450 (18")	787	686	533	101.6	50.8	20	1 7/8"	450 (18")	787	686	595	101.6	R70	533	12.7	19.8	1.52
500 (50")	857	749	584	108	53.8	24	2"	500 (20")	857	747	648	108	R74	584	12.7	19.8	1.52
600 (24")	1041	902	692	139.7	66.5	24	2 1/2"	600 (24")	1041	902	772	139.7	R78	692	15.8	27	2.28

Height of raised face is 1.6mm (0.06") each

Height of raised face is 1.6mm (0.06") each Grv. Groove

ASME Class 1500 Raised Face (in mm)								ASME Class 1500 Ring Type (in mm)								
Valve Size	AØ	BØ	CØ	D	EØ	Bolt No.	Bolt Dia	Valve Size	AØ	BØ	CØ	D	Grv.No.	Pilch Ø - P	Depth E	Width F	Bottam Red .R
50 (2")	216	165	92	38.1	25.4	8	7/8"	50 (2")	216	185	124	38.1	R24	95	8	12	0.76
85 (2 1/2")	244	191	105	41.1	28.4	8	1"	65 (2 1/2")	244	191	137	41.1	R27	108	8	12	0.76
80 (3")	267	203	127	47.8	31.8	8	1 1/8"	80 (3")	241	191	146	38.1	R31	124	8	12	0.76
100 (4")	311	241	157	53.8	35.1	8	1 1/4"	100 (4")	292	235	171	44.5	R37	149	8	12	0.76
125 (5")	375	292	186	73.2	41.1	8	1 1/2"	125 (5")	349	279	209	50.8	R41	181	8	12	0.76
150 (6")	394	318	216	82.6	38.1	12	1 3/8"	150 (6")	381	318	241	55.8	R45	211	8	12	0.76
200 (8")	483	394	270	91.9	44.5	12	1 5/8"	200 (8")	470	394	308	63.5	R49	270	8	12	0.76
250 (10")	584	483	324	108	50.8	12	1 7/8"	250 (10")	546	470	362	69.9	R53	324	8	12	0.76
300 (12")	673	572	381	124	53.8	16	2"	300 (12")	610	533	419	79.2	R57	381	8	12	0.76
350 (14")	749	635	413	133.4	60.5	16	2 1/4"	350 (14")	641	554	467	85.9	R62	419	11.1	16.6	1.52
400 (16")	826	705	470	146.1	66.5	16	2 1/2"	400 (16")	705	616	554	88.9	R66	470	11.1	16.6	1.52
450 (18")	914	775	533	162.1	73.2	16	2 3/4"	450 (18")	787	686	594	101.6	R70	533	12.7	19.8	1.52
500 (20")	984	832	584	177.8	79.2	16	3"	500 (20")	857	749	648	108	R74	584	12.7	19.8	1.52
600 (24")	1168	991	692	203.2	91.9	16	3 3/8"	600 (24")	1041	902	772	1039.7	R78	692	16.8	27	2.28

Height of raised face is 1.6mm (0.06") each

Height of raised face is 1.6mm (0.06") each Grv. Groove

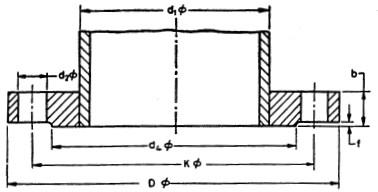
Table 3 Plate Flanges for Welding - IS 6392 - 1971

(Clauses 4.1 and 5.1)

Nominal pressure 0.25 N/mm^2.

All dimensions in millimetres.

Note – For nominal sizes 10 to 1000 mm, use Table 5



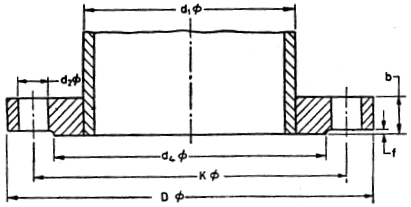
NOM SIZE	PIPE o.d. d1	FLANGE		RAISED FACE		BOLTING	DRILING		
		D	*b*	*d4*	*f*		*No.*	*d2*	*k*
1200	1220	1375	36	1280	5	M27	32	30	1 320
1400	1420	1575	42	1480	5	M27	36	30	1 520
1600	1620	1790	46	1690	5	M27	40	30	1 730
1800	1820	1990	52	1890	5	M27	44	30	1930
2000	2020	2190	58	2090	5	M27	48	30	2130

Table 5 Plate Flanges for Welding - IS 6392 - 1971

(Clauses 4.1 and 5.1)

Nominal pressure 0.60 N/mm^2.

All dimensions in millimetres.



NOM SIZE	PIPE o.d. d1	FLANGE		RAISED FACE		BOLTING	DRILING		
		D	*b*	*d4*	*f*		*No.*	*d2*	*k*
10	17-2	75	12	35	2	M10	4	11	50
15	21-3	80	12	40	2	M10	4	11	55
20	26-9	90	14	50	2	M10	4	11	65
25	33-7	100	14	60	2	M10	4	11	75
32	42-4	120	16	70	2	M12	4	14	90
40	48-3	130	16	80	3	M12	4	14	100
50	60-3	140	16	90	3	M12	4	14	110
65	76-1	160	16	110	3	M12	4	14	130
80	88-9	190	18	120	3	Ml 6	4	18	150
100	114-3	210	18	148	3	M16	4	18	170
125	139-7	240	20	178	3	M16	8	18	200
150	168-3	265	20	202	3	M16	8	18	225
200	219-1	320	22	258	3	M16	8	18	280
250	273	375	24	312	3	M16	12	18	335
300	323-9	440	24	365	4	M20	12	22	395
330	355-6	493	26	415	4	M20	12	22	445
400	406-4	540	28	465	4	M20	16	22	495
500	508	645	30	570	4	M20	20	22	600
600	609-6	755	32	670	5	M24	20	26	705
700	711-2	860	34	775	5	M24	24	26	810
800	812-8	975	38	880	5	M27	24	30	920
900	914-4	1075	42	980	5	M27	24	30	1020
1000	1016	1 175	46	1080	5	M27	28	30	1120
1200	1220	1405	56	1295	5	M30	32	33	1340
1400	1420	1630	66	1510	5	M33	36	36	1560
1600	1620	1830	74	1710	5	M33	40	36	1760
1800	1820	2045	84	1920	5	M36	44	39	1970
2000	2020	2265	92	2125	5	M39	48	42	2180

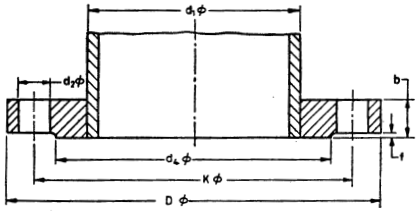
Table 11 Plate Flanges for Welding - IS 6392 - 1971

(Clauses 4.1 and 5.1)

Nominal pressure 1.0 N/mm^2.

All dimensions in millimetres.

Note – For nominal sizes 10 to 175 mm, use Table 17.



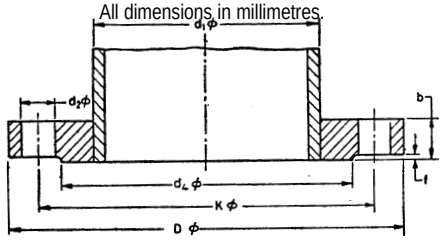
NOM SIZE	PIPE o.d. d1	FLANGE		RAISED FACE		BOLTING	DRILING		
		D	*b*	*d4*	*f*		*No.*	*d2*	*k*
200	219.1	340	24	268	3	M20	8	22	295
250	273	395	26	320	3	M20	12	22	350
300	323.9	445	26	370	4	M20	12	22	400
350	355.8	505	28	430	4	M20	16	22	460
400	406.4	565	32	482	4	M24	16	26	515
500	508	670	38	585	4	M24	20	26	620
600	609.6	780	42	685	5	M27	20	30	725
700	711.2	895	46	800	5	M27	24	30	840
800	812.8	1015	52	905	5	M30	24	33	950
900	914.4	1115	56	1005	5	M30	28	33	1050
1000	1016	1230	62	1110	5	M33	28	36	1160
1200	1220	1455	74	1330	5	M36	32	39	1380

Table 17 Plate Flanges for Welding - IS 6392 - 1971

(Clauses 4.1 and 5.1)

Nominal pressure 1.6 N/mm^2.

All dimensions in millimetres.



NOM SIZE	PIPE o.d. d1	FLANGE		RAISED FACE		BOLTING	DRILING		
		D	*b*	*d4*	*f*		*No.*	*d2*	*k*
10	17-2	90	14	40	2	M12	4	14	60
15	21-3	95	14	45	2	M12	4	14	65
20	26-9	105	16	58	2	M12	4	14	75
25	33-7	115	16	68	2	M12	4	14	85
32	42-4	140	16	78	2	M16	4	18	100
40	48-3	150	16	88	3	M16	4	18	110
50	60-3	165	18	102	3	M16	4	18	125
65	76-1	185	18	122	3	M16	4	18	145
80	88-9	200	20	138	3	M16	8	18	160
100	114-3	220	20	158	3	M16	8	18	180
125	139-7	250	22	188	3	M16	8	18	210
150	168-3	285	22	212	3	M20	8	22	240
175	193-7	315	24	242	3	M20	8	22	270
200	219-1	340	24	268	3	M20	12	22	295
250	273	405	26	320	3	M24	12	26	355
300	323-9	460	28	378	4	M24	12	26	410
350	355-6	520	32	438	4	M24	16	26	470
400	406-4	580	36	490	4	M27	16	30	525
500	508	715	44	610	4	M30	20	33	650
600	609-6	840	52	725	5	M33	20	36	770
700	711-2	910	58	795	5	M33	24	36	840
800	812-8	1025	64	900	5	M36	24	39	950
900	914-4	1125	72	1000	5	M36	28	39	1050
1000	1016	1255	78	1115	5	M39	28	42	1170
1200	1220	1485	94	1330	5	M45	32	48	1390

British Standard Pipe Flanges-BS 10 Tables "D" and "E"

STAINLESS STEEL, 'MONEL' CAST STEEL, BRONZE

Nominal Pipe Size	Flange Diameter Both Tables	Flange Thickness			Number of Bolts			Size of Bolts			Diameter of Bolt Both Tables
		'D'	Both Tables	'E'	'D'	Both Tables	'E'	'D'	Both Tables	'E'	
1/2"	3 3/4"		3/8"			4			1/2"		2 5/8"
3/4"	4"		3/8"			4			1/2"		2 7/8"
1"	4 1/2"		3/8"			4			1/2"		3 1/4"
1 1/4"	4 3/4"		1/2"			4			1/2"		3.7/16"
1 1/2"	5 1/4"		1/2"			4			1/2"		3 7/8"
2"	6"		9/16"			4			5/8"		4 3/4"
2 1/2"	6 1/2"		9/16"			4			5/8"		5 1/2"
3	7 1/4"		9/16"			4			5/8"		5 3/4"
4"	8 1/2"		11/16"		4		8		5/8"		7"
5"	10"		11/16"			8			5/8"		8 1/4"
6"	11"		11/16"			8		5/8"		3/4"	9 1/4"
8"	13 1/4"		3/4"			8		5/8"		3/4"	11 1/2"
10"	16"	3/4"		7/8"	8		12		3/4"		14"
12"	18"	7/8"		1"		12		3/4"		7/8"	16"
14"	20 3/4"		1"			12			7/8"		18 1/2"
16"	22 3/4"		1"			12			7/8"		20 1/2"
18"	25 1/4"		1 1/8"		12		16		7/8"		23"
20"	27 3/4"		1 1/4"	1 3/8"		16			7/8"		25 1/4"
21"	29"	1 3/8"		1 1/2"		16		7/8"		1"	26 1/2"
24"	32 1/2"	1 1/2"				16			1"		29 3/4"

British Standard Pipe Flanges – BS10 Tables "F" and "H"

CAST STEEL, BRONZE, STAINLESS STEEL, 'MONEL'

Nominal Pipe Size	Flange Diameter			Flange Thickness		Number of Bolts all Tables	Size of Bolts			Diam. of Bolt Circle		
	'F'	Both Tables	'H'	'F'	'H'		'F'	Both Tables	'H'	'F'	Both Tables	'H'
1/2"	3 3/4"		4 1/2"	3/8"	1/2"	4	1/2"		5/8"	2 5/8"		3 1/4"
3/4"	4"		4 1/2"	3/8"	1/2"	4	1/2"		5/8"	2 7/8"		3 1/4"
1"		4 3/4"		3/8"	9/16"	4		5/8"			3.7/16"	
1 1/4"		5 1/4"		1/2"	11/16"	4		5/8"			3 7/8"	
1 1/2"		5 1/2"		1/2"	11/16"	4		5/8"			4 1/8"	
2"		6 1/2"		5/8"	3/4"	4		5/8"			5"	
2 1/2"		7 1/4"		5/8"	3/4"	8		5/8"			5 3/4"	
3		8"		5/8"	7/8"	8		5/8"			6 1/2"	
4"		9"		3/4"	1"	8		5/8"			7 1/2"	
5"		11"		7/8"	1 1/8"	8		3/4"			9 1/4"	
6"		12"		7/8"	1 1/8"	12		3/4"			10 1/4"	
8"		14 1/2"		1"	1 1/4"	12		3/4"			12 3/4"	
10"		17" 1/4"		1"	1 3/8"	12		7/8"			15"	
12"		19 1/4"		1 1/8"	1 1/2"	16		7/8"			17 1/4"	
14"		21 3/4"		1 1/4"	1 5/8"	16		1"			19 1/2"	
16"		24"		1 1/4"	1 3/4"	20		1"			21 3/4"	
18"		26 1/2"		1 3/8"	1 7/8"	20		1 1/8"			24"	
20"		29"		1 1/2"	2"	24		1 1/8"			26 1/2"	
21"		30"		1 1/2"	2 1/8"	24		1 1/8"			27 1/2"	
24"		33 1/2"		1 5/8"	2 1/4"	24		1 1/4"			30 3/4"	

Note : The thickness of Aduco valve flanges may in certain instances be greater than the dimensions specified above.

British Standard Pipe Flanges for the Petroleum industry and American Standard Pipe Flanges

CLASS 150 STEEL RAISED FACE FLANGES

Nominal Bore	Flange Diameter	Flange Thickness	1/16" Raised Face Diam. Class 150 Steel only	Number of Bolts	Sizes of Bolts	Bolt Circle Diameter
1"	4 1/4"	7/16"	2"	4	1/2"	3 1/8"
1 1/4"	4 5/8"	1/2"	2 1/2"	4	1/2"	3 1/2"
1 1/2"	5"	9/16"	2 7/8"	4	1/2"	3 7/8"
2"	6"	5/8"	3 5/8"	4	5/8"	4 3/4"
2 1/2"	7"	11/16"	4 1/8"	4	5/8"	5 1/2"
3"	7 1/2"	3/4"	5"	4	5/8"	6"
4"	9"	15/16"	6.3/16"	8	5/8"	7 1/2"
5"	10"	15/16"	7.5/16"	8	3/4"	8 1/2"
6"	11"	1"	8 1/2"	8	3/4"	9 1/2"
8"	13 1/2"	1 1/8"	10 5/8"	8	3/4"	11 3/4"
10"	16"	1.3/16"	12 3/4"	12	7/8"	14 1/4"
12"	19"	1 1/4"	15"	12	7/8"	17"
14"	21"	1 1/8"	16 1/4"	12	1"	18 3/4"
16"	23 1/2"	1.7/16"	18 1/2"	16	1"	21 1/4"
18"	25"	1.9/16"	21"	16	1 1/8"	22 3/4"
20"	27 1/2"	1.11/16"	23"	20	1 1/8"	25"
24"	32"	1 7/8"	27 1/4"	20	1 1/4"	29 1/2"

CLASS 300 STEEL RAISED FACE FLANGES

Nominal Bore	Flange Diameter	Flange Thickness	1/16" Raised Face Dia Class 300 Steel	Number of Bolts	Size of Bolts	Bolts Circle Diameter
1/2"	3 1/4"*	9/16"*	1 3/8"	4	1/2"	2 5/8"
3/4"	4 5/8"*	5/8"*	1.11/16"	4	5/8"	3 1/4"
1"	4 7/8"	11/16"	2"	4	5/8"	3 1/2"
1 1/4"	5 1/4"	3/4"	2 1/2"	4	5/8"	3 7/8"
1 1/2"	6 1/8"	13/16"	2 7/8"	4	3/4"	4 1/2"
2"	6 1/2"	7/8"	3 5/8"	8	5/8"	5"
2 1/2"	7 1/2"	1"	4 1/8"	8	3/4"	5 7/8"
3"	8 1/4"	1 1/8"	5"	8	3/4"	6 5/8"
4"	10"	1 1/4"	6.3/16"	8	3/4"	7 7/8"
5"	11"	1 3/8"	7.5/16"	8	3/4"	9 1/4"
6"	12 1/2"	1.7/16"	8 1/2"	12	3/4"	10 5/8"
8"	15"	1 5/8"	10 5/8"	12	7/8"	13"
10"	17 1/2"	1 7/8"	12 3/4"	16	1"	15 1/4"
12"	20 1/2"	2"	15"	16	1 1/8"	17 3/4"
14"	23"	2 1/8"	16 1/4"	20	1 1/8"	20 1/4"
16"	25 1/2"	2 1/4"	18 1/2"	20	1 1/4"	22 1/2"
18"	28"	2 3/8"	21"	24	1 1/4"	24 3/4"
20"	30 1/2"	2 1/2"	23"	24	1 1/4"	27"
24"	36"	2 3/4"	27 1/4"	24	1 1/2"	32"

Audco Valves are made to the dimensions in the above tables.

Flange Table DIN 2501

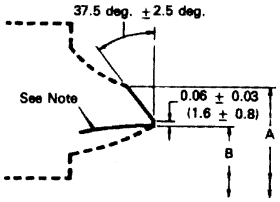
Nominal Pressure	Nominal Pressure 1 + 2, 5				Nominal Pressure 8				Nominal Pressure 10				Nominal Pressure 16			
Nominal diameter	Flange diameter	Pitch circle diameter	Number of bolts	Diameter of bolt holes	Flange diameter	Pitch circle diameter	Number of bolts	Diameter of bolt holes	Flange diameter	Pitch circle diameter	Number of bolts	Diameter of bolt holes	Flange diameter	Pitch circle diameter	Number of bolts	Diameter of bolt holes
ND	D	k		l	D	k		l	D	k		l	D	k		l
15	80	55	4	11	80	55	4	11	95	65	4	14	95	65	4	14
20	90	65	4	11	90	65	4	11	105	75	4	14	105	75	4	14
25	100	75	4	11	100	75	4	11	115	85	4	14	115	85	4	14
32	120	90	4	14	120	90	4	14	140	100	4	18	140	100	4	18
40	130	100	4	14	130	100	4	14	150	110	4	18	150	110	4	18
50	140	110	4	14	140	110	4	14	165	125	4	18	165	125	4	18
65	160	130	4	14	160	130	4	14	185	145	4	18	185	145	4	18
80	190	150	4	18	190	150	4	18	200	160	8	18	200	160	8	18
100	210	170	4	18	210	170	4	18	220	180	8	18	220	180	8	18
125	240	200	8	18	240	200	8	18	250	210	8	18	250	210	8	18
150	265	225	8	18	265	225	8	18	285	240	8	22	• 285	240	8	22
(175)	—	—	—	—	—	—	—	—	315	270	8	22	315	270	8	22
200	320	280	8	18	320	280	8	18	340	295	8	22	340	295	12	22
250	375	335	12	18	375	335	12	18	395	350	12	22	405	355	12	26
300	440	395	12	22	440	395	12	22	445	400	12	22	460	410	12	26
350	490	445	12	22	490	445	12	22	505	460	16	22	520	470	16	26
400	540	495	16	22	540	495	16	22	565	515	16	26	580	525	16	30
(450)	595	550	16	22	595	550	16	22	615	565	20	26	640	585	20	30
500	645	600	20	22	645	600	20	22	670	620	20	26	715	650	20	33
600	755	705	20	26	755	705	20	26	780	725	20	30	840	770	20	36
700	860	810	24	26	860	810	24	26	895	840	24	30	910	840	24	36
800	975	920	24	30	975	920	24	30	1015	950	24	33	1025	950	24	39
900	1075	1020	24	30	1075	1020	24	30	1115	1050	28	33	1125	1050	28	39
1000	1175	1120	28	30	1175	1120	28	30	1230	1160	28	36	1255	1170	28	42
1200	1375	1320	32	30	1405	1340	32	33	1455	1380	32	39	1485	1390	32	48
1400	1575	1520	36	30	1630	1560	36	36	1675	1590	36	42	1685	1590	36	48
1600	1790	1730	40	30	1830	1760	40	36	1915	1820	40	48	1930	1820	40	56
1800	1990	1930	44	30	2045	1970	44	39	2115	2020	44	48	2130	2020	44	56
2000	2190	2130	48	30	2265	2180	48	42	2325	2230	48	48	2345	2230	48	62
2200	2405	2340	52	33	2475	2390	52	42	2550	2440	52	56	2555	2440	52	62
2400	2605	2540	56	33	2685	2600	56	42	2760	2650	56	56				
2600	2805	2740	60	33	2905	2810	60	48	2960	2850	60	56				
2800	3030	2960	64	36	3115	3020	64	48	3180	3070	64	56				
3000	3230	3160	68	36	3315	3220	68	48	3405	3290	68	62				
3200	3430	3360	72	36	3525	3430	72	48								
3400	3630	3560	76	36	3735	3640	76	48								
3600	3840	3770	80	36	3970	3860	80	56								
3800	4045	3970	80	39												
4000	4245	4170	84	39												

Flange Table DIN 2501

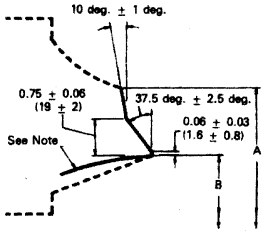
Nominal Pressure	Nominal Pressure 25				Nominal Pressure 40				Nominal Pressure 64				Nominal Pressure 100			
Nominal diameter	Flange diameter	Pitch circle diameter	Number of bolts	Diameter of bolt holes	Flange diameter	Pitch circle diameter	Number of bolts	Diameter of bolt holes	Flange diameter	Pitch circle diameter	Number of bolts	Diameter of bolt holes	Flange diameter	Pitch circle diameter	Number of bolts	Diameter of bolt holes
ND	D	k		l	D	k		l	D	k		l	D	k		l
15	95	65	4	14	95	65	4	14	105	75	4	14	105	75	4	14
20	105	75	4	14	105	75	4	14	—	—	—	—	—	—	—	—
25	115	85	4	14	115	85	4	14	140	100	4	18	140	100	4	18
32	140	100	4	18	140	100	4	18	—	—	—	—	—	—	—	—
40	150	110	4	18	150	110	4	18	170	125	4	22	170	125	4	22
50	165	125	4	18	165	125	4	18	180	135	4	22	195	145	4	26
65	185	145	8	18	185	145	8	18	205	160	8	22	220	170	8	26
80	200	160	8	18	200	160	8	18	215	170	8	22	230	180	8	26
100	235	190	8	22	235	190	8	22	250	200	8	26	265	210	8	30
125	270	220	8	26	270	220	8	26	295	240	8	30	315	250	8	33
150	300	250	8	26	300	250	8	26	345	280	8	33	355	290	12	33
(175)	330	280	12	26	350	295	12	30	375	310	12	33	385	320	12	33
200	360	310	12	26	375	320	12	30	415	345	12	36	430	360	12	36
250	425	370	12	30	450	385	12	33	470	400	12	36	505	430	12	39
300	485	430	16	30	515	450	16	33	530	460	16	36	585	500	16	42
350	555	490	16	33	580	510	16	36	600	525	16	39	655	560	16	48
400	620	550	16	36	660	585	16	39	670	585	16	42	715	620	16	48
(450)	—	—	—	—	685	610	20	39	—	—	—	—	—	—	—	—
500	730	660	20	36	755	670	20	42	800	705	20	48	870	760	20	56
600	845	770	20	39	890	795	20	48	930	820	20	56	990	875	20	62
700	960	875	24	42	995	900	24	48	1045	935	24	56	1145	1020	24	70
800	1085	990	24	48	1140	1030	24	56	1165	1050	24	62				
900	1185	1090	28	48	1250	1140	28	56	1285	1170	28	62				
1000	1320	1210	28	56	1360	1250	28	56	1415	1290	28	70				
1200	1530	1420	32	56	1575	1460	32	62	1665	1530	32	78				
1400	1755	1640	36	62	1795	1680	36	62								
1600	1975	1860	40	62	2025	1900	40	70								
1800	2195	2070	44	70												
2000	2425	2300	48	70												
2200																
2400																
2600																
2800																
3000																
3200																
3400																
3600																
3800																
4000																

4. Butt-weld Dimensions & Details - ASME B16.25, 1997

Welding and detail for joint without backing ring



Intended for use on 22mm. (0.88") and thinner nominal wall thickness.



Intended for use on wall thickness grater than 22mm (0.88")

Note : Internal surface may be reformed or machined for dimensions B at root face. Contour within the envelope is manufacturer's option, unless otherwise specifically order for.

Nominal	A	B										
Pipe size		STD	XS	30	40	60	80	100	120	140	100	XXS
65 (2/2")	75	-	-	-	63	-	59	-	-	-	54	45
80 (3")	91	-	-	-	78	-	74	-	-	-	67	58
100 (4")	117	-	-	-	102	-	97	-	92	-	87	80
125 (5")	144	-	-	-	128	-	122	-	116	-	110	103
150 (6")	172	-	-	-	154	-	148	-	140	-	132	124
200 (8")	223	-	-	-	203	198	194	189	183	178	173	175
250 (10")	278	-	-	-	255	247	242	237	230	222	216	-
300 (12")	329	305	298	-	303	295	289	281	273	267	257	-
350 (14")	362	337	330	-	333	325	318	308	300	292	284	-
400 (16")	413	387	-	-	381	373	364	354	344	333	325	-
450 (18")	464	438	432	-	429	419	410	396	387	378	367	-
500 (20")	516	489	483	-	478	467	456	443	432	419	408	-
600 (24")	619	591	584	581	575	560	548	532	518	505	491	-

5. Pipe Thickness Tables (Extract from ASME B36:10 M-1985)

Dimensions and Weights of Welded and Seamless Wrought Steel Pipe

Customary Units				Identification			SI Units		
Inch Nominal Size	Outside Diameter, in	Wall Thickness, in.	Plain End Weight lb/ft	APl Spec.	(STD) (XS) (XXS)	Schedule No.	Outside Diameter, mm	Wall Thickness mm	Plain End Mass, kg/m
⅛	0.405	0.068	0.24	5L	STD	40	10.3	1.73	0.37
⅛	0.405	0.095	0.31	5L	XS	80	10.3	2.41	0.47
¼	0.540	0.088	0.42	5L	STD	40	13.7	2.24	0.63
¼	0.540	0.119	0.54	5L	XS	80	13.7	3.02	0.80
⅜	0.675	0.091	0.57	5L	STD	40	17.1	2.31	0.84
⅜	0.675	0.126	0.74	5L	XS	80	17.1	3.20	1.10
½	0.840	0.109	0.85	5L	STD	40	21.3	2.77	1.27
½	0.840	0.147	1.09	5L	XS	80	21.3	3.73	1.62
½	0.840	0.294	1.71	5L	XXS	...	21.3	7.47	2.55
¾	1.050	0.113	1.13	5L	STD	40	26.7	2.87	1.69
¾	1.050	0.154	1.47	5L	XS	80	26.7	3.91	2.20
¾	1.050	0.308	2.44	5L	XXS	...	26.7	7.82	3.64
1	1.315	0.133	1.68	5L	STD	40	33.4	3.38	2.50
1	1.315	0.179	2.17	5L	XS	80	33.4	4.55	3.24
1	1.315	0.358	3.66	5L	XXS	...	33.4	9.09	5.45
1¼	1.660	0.140	2.27	5L	STD	40	42.2	3.56	3.39
1¼	1.660	0.191	3.00	5L	XS	80	42.2	4.85	4.47
1¼	1.660	0.382	5.21	5L	XXS	...	42.2	9.70	7.77
1½	1.900	0.145	2.72	5L	STD	40	48.3	3.68	4.05
1½	1.900	0.200	3.63	5L	XS	80	48.3	5.08	5.41
1½	1.900	0.400	6.41	5L	XXS	...	48.3	10.15	9.56

STD - Standard **XS - Extra-Strong** **XXS - Double Extra-Strong**

Dimensions and Weights of Welded and Seamless Wrought Steel Pipe (Cont'd)

Customary Units				Identification			SI Units		
Inch Nominal Size	Outside Diameter, in	Wall Thickness, in.	Plain End Weight lb/ft	APl Spec.	(STD) (XS) (XXS)	Schedule No.	Outside Diameter, mm	Wall Thickness mm	Plain End Mass, kg/m
2	2.375	0.154	3.65	5L	STD	40	60.3	3.91	5.44
2	2.375	0.218	5.02	5L	XS	80	60.3	5.54	7.48
2½	2.875	0.203	5.79	5L	STD	40	73.0	5.16	8.63
2½	2.875	0.276	7.66	5L	XS	80	73.0	7.01	11.41
2½	2.875	0.552	13.69	5L	XXS	...	73.0	14.02	20.39
3	3.500	0.216	7.58	5L	STD	40	88.9	5.49	11.29
3	3.500	0.300	10.25	5L	XS	80	88.9	7.62	15.27
3	3.500	0.600	18.58	5L	XXS	...	88.9	15.24	27.68
3½	4.000	0.226	9.11	5L	STD	40	101.6	5.74	13.57
3½	4.000	0.318	12.50	5L	XS	80	101.6	8.08	18.63
4	4.500	0.237	10.79	5L	STD	40	114.3	6.02	16.07
4	4.500	0.337	14.98	5L	XS	80	114.3	8.56	22.32
4	4.500	0.438	19.00	5L	...	120	114.3	11.13	28.32
4	4.500	0.531	22.51	5L	...	160	114.3	13.49	33.54
4	4.500	0.674	27.54	5L	XXS	...	114.3	17.12	41.03
5	5.563	0.258	14.62	5L	STD	40	141.3	6.55	21.77
5	5.563	0.375	20.78	5L	XS	80	141.3	9.53	30.97
5	5.563	0.500	27.04	5L	...	120	141.3	12.70	40.28
5	5.563	0.625	32.96	5L	...	160	141.3	15.88	49.11
5	5.563	0.750	38.55	5L	XXS	...	141.3	19.05	57.43
6	6.625	0.280	18.97	5L	STD	40	168.3	7.11	28.26
6	6.625	0.432	28.57	5L	XS	80	168.3	10.97	42.56
6	6.625	0.562	36.39	5L	...	120	168.3	14.27	54.20
6	6.625	0.719	45.35	5L	...	160	168.3	18.26	67.56
6	6.625	0.864	53.16	...	XXS	...	168.3	21.95	79.22
8	8.625	0.250	22.36	5L	...	20	219.1	6.35	33.31
8	8.625	0.277	24.70	5L	...	30	219.1	7.04	36.81
8	8.625	0.500	43.39	5L	XS	80	219.1	12.70	64.64
8	8.625	0.719	60.71	5L	...	120	219.1	18.26	90.44

STD - Standard XS - Extra-Strong XXS - Double Extra-Strong

Dimensions and Weights of Welded and Seamless Wrought Steel Pipe (Cont'd)

Customary Units				Identification			SI Units		
Inch Nominal Size	Outside Diameter, in	Wall Thickness, in.	Plain End Weight lb/ft	APl Spec.	(STD) (XS) (XXS)	Schedule No.	Outside Diameter, mm	Wall Thickness mm	Plain End Mass, kg/m
8	8.625	0.812	67.76	5L	...	140	219.1	20.62	100.92
8	8.625	0.875	72.42	5L	XXS	...	219.1	22.23	107.92
10	10.750	0.250	28.04	5L	...	20	273.0	6.35	41.77
10	10.750	0.307	34.24	5L	...	30	273.0	7.80	51.03
10	10.750	0.365	40.48	5L	STD	40	273.0	9.27	60.31
10	10.750	0.500	54.74	5L	XS	60	273.0	12.70	81.55
10	10.750	0.719	77.03	5L	...	100	273.0	18.26	114.75
10	10.750	1.000	104.13	5L	XXS	140	273.0	25.40	155.15
12	12.750	0.250	33.38	5L	...	20	323.8	6.35	49.73
12	12.750	0.330	43.77	5L	...	30	323.8	8.38	65.20
12	12.750	0.375	49.56	5L	STD	...	323.8	9.53	73.88
12	12.750	0.406	53.52	5L	...	40	323.8	10.31	79.73
12	12.750	0.500	65.42	5L	XS	...	323.8	12.70	97.46
12	12.750	0.562	73.15	5L	...	60	323.8	14.27	108.96
12	12.750	0.688	88.63	5L	...	80	323.8	17.48	132.08
12	12.750	0.844	107.32	...	...	100	323.8	21.44	159.91
12	12.750	1.000	125.49	5L	XXS	120	323.8	25.40	186.97
12	12.750	1.125	139.67	5L	...	140	323.8	28.58	208.14
12	12.750	1.312	160.27	5L	...	160	323.8	33.32	238.76
14	14.000	0.250	36.71	5L	...	10	355.6	6.35	54.69
14	14.000	0.312	45.61	5L	...	20	355.6	7.92	67.90
14	14.000	0.375	54.57	5L	STD	30	355.6	9.53	81.33
14	14.000	0.438	63.44	5L	...	40	355.6	11.13	94.55
14	14.000	0.500	72.09	5L	XS	...	355.6	12.70	107.39
14	14.000	0.594	85.05	...	...	60	355.6	15.09	126.71
14	14.000	0.750	106.13	5L	...	80	355.6	19.05	158.10
14	14.000	0.938	130.85	5L	...	100	355.6	23.83	194.96
14	14.000	1.094	150.79	...	...	120	355.6	27.79	224.65
14	14.000	1.250	170.21	5L	...	140	355.6	31.75	253.56
14	14.000	1.406	189.11	...	...	160	355.6	50.80	381.83
16	16.000	0.250	42.05	5L	...	10	406.4	6.35	62.64
16	16.000	0.312	52.27	5L	...	20	406.4	7.92	77.83
16	16.000	0.375	62.58	5L	STD	30	406.4	9.53	93.27
16	16.000	0.500	82.77	5L	XS	40	406.4	12.70	123.30
16	16.000	0.656	107.50	...	...	60	406.4	16.66	160.12
16	16.000	0.844	136.61	...	...	80	406.4	21.44	203.53
16	16.000	1.031	164.82	...	...	100	406.4	26.19	245.56
16	16.000	1.219	192.43	...	...	120	406.4	30.96	286.64

STD - Standard XS - Extra-Strong XXS - Double Extra-Strong

Dimensions and Weights of Welded and Seamless Wrought Steel Pipe (Cont'd)

Customary Units				Identification			SI Units		
Inch Nominal Size	Outside Diameter, in	Wall Thickness, in.	Plain End Weight lb/ft	APl Spec.	(STD) (XS) (XXS)	Schedule No.	Outside Diameter, mm	Wall Thickness mm	Plain End Mass, kg/m
16	16.000	1.438	223.64	...	...	140	406.4	36.53	333.19
16	16.000	1.594	245.25	...	...	160	406.4	40.49	365.35
18	18.000	0.250	47.39	5L	...	10	457	6.35	70.57
18	18.000	0.312	58.94	5L	...	20	457	7.92	87.71
18	18.000	0.375	70.59	5L	STD	...	457	9.53	105.16
18	18.000	0.438	82.15	5L	...	30	457	11.13	122.38
18	18.000	0.500	93.45	5L	XS	...	457	12.70	139.15
18	18.000	0.562	104.67	5L	...	40	457	14.27	155.80
18	18.000	0.750	138.17	5L	...	60	457	19.05	205.74
18	18.000	0.938	170.92	5L	...	80	457	23.83	254.55
18	18.000	1.156	207.96	...	...	100	457	29.36	309.62
18	18.000	1.375	244.14	...	...	120	457	34.93	363.56
18	18.000	1.562	274.22	...	...	140	457	39.67	408.26
18	18.000	1.781	308.50	...	...	160	457	45.24	459.37
20	20.000	0.250	52.73	5L	...	10	508	6.35	78.55
20	20.000	0.375	78.60	5L	STD	20	508	9.53	117.15
20	20.000	0.500	104.13	5L	XS	30	508	12.70	155.12
20	20.000	0.594	123.11	...	...	40	508	15.09	183.42
20	20.000	0.812	166.40	5L	...	60	508	20.62	247.83
20	20.000	1.031	208.87	...	...	80	508	26.19	311.17
20	20.000	1.281	256.10	...	...	100	508	32.54	381.53
20	20.000	1.500	296.37	...	...	120	508	38.10	441.49
20	20.000	1.750	341.09	...	...	140	508	44.45	508.11
20	20.000	1.969	379.17	...	...	160	508	50.01	564.81
22	22.000	0.250	58.07	5L	...	10	559	6.35	86.54
22	22.000	0.375	86.61	5L	STD	20	559	9.53	129.13
22	22.000	0.500	114.81	5L	XS	30	559	12.70	171.09
22	22.000	0.875	197.41	5L	...	60	559	22.23	294.25
22	22.000	1.125	250.81	5L	...	80	559	28.58	373.83
22	22.000	1.375	302.88	5L	...	100	559	34.93	451.42
22	22.000	1.625	353.61	...	...	120	559	41.28	527.02
22	22.000	1.875	403.00	...	...	140	559	47.63	600.63
22	22.000	2.125	451.06	...	...	160	559	53.98	672.26
24	24.000	0.250	63.41	5L	...	10	610	6.35	94.53
24	24.000	0.375	94.62	5L	STD	20	610	9.53	141.12
24	24.000	0.500	125.49	5L	XS	...	610	12.70	187.06
24	24.000	0.562	140.68	5L	...	30	610	14.27	209.64
24	24.000	0.688	171.29	5L	...	40	610	17.48	255.41

STD - Standard XS - Extra-Strong XXS - Double Extra-Strong

Dimensions and Weights of Welded and Seamless Wrought Steel Pipe (Cont'd)

Customary Units				Identification			SI Units		
Inch Nominal Size	Outside Diameter, in	Wall Thickness, in.	Plain End Weight lb/ft	APl Spec.	(STD) (XS) (XXS)	Schedule No.	Outside Diameter, mm	Wall Thickness mm	Plain End Mass, kg/m
24	24.000	0.969	238.35	...	...	60	610	24.61	355.26
24	24.000	1.219	296.58	...	...	80	610	30.96	442.08
24	24.000	1.531	367.39	...	...	100	610	38.89	547.71
24	24.000	1.812	429.39	...	...	120	610	46.02	640.03
24	24.000	2.062	483.12	...	...	140	610	52.37	720.15
24	24.000	2.344	542.13	...	...	160	610	59.54	808.22
26	26.000	0.312	85.60	5L	...	10	660	7.92	127.36
26	26.000	0.375	102.63	5L	STD	...	660	9.53	152.87
26	26.000	0.500	136.17	5L	XS	20	660	12.70	202.72
28	28.000	0.312	92.26	5L	...	10	711	7.92	137.32
28	28.000	0.375	110.64	5L	STD	...	711	9.53	164.85
28	28.000	0.500	146.85	5L	XS	20	711	12.70	218.69
28	28.000	0.625	182.73	5L	...	30	711	15.88	271.21
30	30.000	0.312	98.93	5L	...	10	762	7.92	147.28
30	30.000	0.375	118.65	5L	STD	...	762	9.53	176.84
30	30.000	0.500	157.53	5L	XS	20	762	12.70	234.67
30	30.000	0.625	196.08	5L	...	30	762	15.88	292.18
32	32.000	0.312	105.59	5L	...	10	813	7.92	157.24
32	32.000	0.375	126.66	5L	STD	...	813	9.53	188.82
32	32.000	0.500	168.21	5L	XS	20	813	12.70	250.64
32	32.000	0.625	209.43	5L	...	30	813	15.88	312.15
32	32.000	0.688	230.08	5L	...	40	813	17.48	342.91
34	34.000	0.312	112.25	5L	...	10	864	7.92	167.20
34	34.000	0.375	134.67	5L	STD	...	864	9.53	200.31
34	34.000	0.500	178.89	5L	XS	20	864	12.70	266.61
34	34.000	0.625	222.78	5L	...	30	864	15.88	332.12
34	34.000	0.688	244.77	5L	...	40	864	17.48	364.90
36	36.000	0.312	118.92	5L	...	10	914	7.92	176.96
36	36.000	0.375	142.68	5L	STD	...	914	9.53	212.56
36	36.000	0.500	189.57	5L	XS	20	914	12.70	282.27
36	36.000	0.625	236.13	5L	...	30	914	15.88	351.70
36	36.000	0.750	282.35	5L	...	40	914	19.05	420.42
38	38.000	0.375	150.69	5L	STD	...	965	9.53	224.54
38	38.000	0.500	200.25	5L	XS	...	965	12.70	298.24
40	40.000	0.375	158.70	5L	STD	...	1016	9.53	236.53
40	40.000	0.500	210.93	5L	XS	...	1016	12.70	314.22
42	42.000	0.375	166.71	5L	STD	...	1067	9.53	248.52
42	42.000	0.500	221.61	5L	XS	...	1067	12.70	330.19
44	44.000	0.375	174.72	5L	STD	...	1118	9.53	260.50

STD - Standard XS - Extra-Strong XXS - Double Extra-Strong

Dimensions and Weights of Welded and Seamless Wrought Steel Pipe (Cont'd)

Customary Units				Identification			SI Units		
Inch Nominal Size	Outside Diameter, in	Wall Thickness, in.	Plain End Weight lb/ft	APl Spec.	(STD) (XS) (XXS)	Schedule No.	Outside Diameter, mm	Wall Thickness mm	Plain End Mass, kg/m
44	44.000	0.500	232.29	5L	XS	...	1118	12.70	346.16
46	46.000	0.375	182.73	5L	STD	...	1168	9.53	272.25
46	46.000	0.500	242.97	5L	XS	...	1168	12.70	351.82
48	48.000	0.375	190.74	5L	STD	...	1219	9.53	284.24
48	48.000	0.500	253.65	5L	XS	...	1219	12.70	377.79
52	52.000	0.375	206.76	5L	...	...	1321	9.53	308.21
52	52.000	0.406	223.72	5L	...	...	1321	10.31	333.24
52	52.000	0.438	241.20	5L	...	...	1321	11.13	359.51
52	52.000	0.469	258.11	5L	...	...	1321	11.91	384.48
52	52.000	0.500	275.01	5L	...	...	1321	12.70	409.64
52	52.000	0.562	308.74	5L	...	...	1321	14.27	459.84
52	52.000	0.625	342.93	5L	...	...	1321	15.88	511.09
52	52.000	0.688	377.03	5L	...	...	1321	17.48	561.89
52	52.000	0.750	410.51	5L	...	...	1321	19.05	611.62
52	52.000	0.812	443.91	5L	...	...	1321	20.62	661.23
52	52.000	0.875	477.76	5L	...	...	1321	22.23	711.98
52	52.000	0.938	511.53	5L	...	...	1321	23.83	762.28
52	52.000	1.000	544.68	5L	...	...	1321	25.40	811.52
52	52.000	1.061	577.75	5L	...	...	1321	26.97	860.63
52	52.000	1.125	611.26	5L	...	...	1321	28.58	910.88
52	52.000	1.188	644.69	5L	...	...	1321	30.18	960.68
52	52.000	1.250	677.51	5L	...	...	1321	31.75	1009.42
56	56.000	0.375	222.78	5L	...	...	1422	9.53	331.94
56	56.000	0.406	241.06	5L	...	...	1422	10.31	358.91
56	56.000	0.438	259.91	5L	...	...	1422	11.13	387.24
56	56.000	0.469	278.15	5L	...	...	1422	11.91	414.14
56	56.000	0.500	296.37	5L	...	...	1422	12.70	441.37
56	56.000	0.562	332.75	5L	...	...	1422	14.27	495.38
56	56.000	0.625	369.63	5L	...	...	1422	15.88	550.54
56	56.000	0.688	406.42	5L	...	...	1422	17.48	605.43
56	56.000	0.750	442.55	5L	...	...	1422	19.05	659.07
56	56.000	0.812	478.60	5L	...	...	1422	20.62	712.59
56	56.000	0.875	515.14	5L	...	...	1422	22.23	767.34
56	56.000	0.938	551.60	5L	...	...	1422	23.83	821.63
56	56.000	1.000	587.40	5L	...	...	1422	25.40	875.78
56	56.000	1.062	623.12	5L	...	...	1422	26.97	927.81
56	56.000	1.125	659.32	5L	...	...	1422	28.58	982.06
56	56.000	1.188	695.45	5L	...	...	1422	30.18	1035.85
56	56.000	1.250	730.91	5L	...	...	1422	31.75	1088.50

STD - Standard **XS - Extra-Strong** **XXS - Double Extra-Strong**

6. Pressure Drop for Liquids

Basic equation for liquids

$q = C_v\sqrt{\triangle P/G}$

where

Q = Flow rate in gallons per minute

C_v = Value coefficient

$\triangle$ P = Pressure differential in psi

G = Specific gravity of the fluid

1. Material Composition

Noml. Desn.	Form of Matl.	Standard	Chemical - Composition %													Mechanical Properties					Remarks
			C	Mn	P	S	SI	NI	Cr	Mo	AI	Cu	Va	W		T.S	Y.S	Elgn. %	R.A. %	Hard BHN	
CAST IRON	Casting	IS 210 Gr. FG 220-1993 Rev. 4	Discretion of Manufacturer													220 Mpa	-	-	-	180 220 BHN	Gauge dia 20±0.5 mm
MALLABLE IRON	Casting	BS 1452-Gr. 220 1990	Not spelt out													220 N/mm²	-	-	-	Ref. Std.	*Sepe.cast test sample
ALUMN BRONZE	Casting	BS 1400 (AB2) 1985 Amd. 1		3.0		Fe 4.0 5.5	0.1	4.0 5.5		Ph 0.0	8.8 10.0	Rem-inder	Sn 0.1	Zn 0.5	Mg 0.05		(Ref. Std.)				Total of Impurities S 0.2
Carbon Steel	Casting	ASTM A216 Gr.WCB-93	0.3	1.0	0.04	0.045	0.6	0.5 R	0.5 R	0.2 R	-	0.3 R	0.03 R		R=1 max	70 95	36	22	35		
	Forging	ASTM A105 95b	0.35	0.60 1.05	0.04	0.05	0.35 0.10	0.4 R	0.3 R	0. 12 R	-	0.4 R	0.03	Cb 0.02		70	36	22	30	187 137	Cr+Mo≤.0.32 Cu+N1+Cr+Mo≤1
Martensitic Steel	Casting	ASTM A217 C5-95	0.2	0.4 0.7	0.04	0.045	0.75	0.5 R	4.0 6.5	0.45 0.65	-	0.5 R	-	0.1 R	R = 1 Max.	90 115	60	18	35		
	Casting	ASTM A217 CA15-95	0.15	1.0	0.04	0.04	1.5	1.0	11.5 14.0	0.5	-	-	-	-	-	90 115	65	18	30		
	Casting	ASTM A217 WC6-95	0.05 0.2	0.5 0.8	0.04	0.045	0.6	0.5 R	1.0 1.5	0.45 0.65	-	0.5 R	-	0.1 R	R=1 max.	70 95	40	20	35		
	Casting	ASTM A217 WC9-95	0.05 0.18	0.4 0.7	0.04	0.045	0.6	0.5 R	2.0 2.75	0.9 1.2	-	0.5 R	-	0.1 R	R=1 max.	70 95	40	20	35		
Ferritic Steel	Casting	ASTM A352 LCB-93	0.3	1.0	0.04	0.045	0.6	0.5 R	0.5 R	0.2 R	-	0.3 R	0.03 R	-	R=1 max.	65 90	35	24	35		Impact 13 ave. Min -10-ft. lbs
Austenitic Steel 316-CF8M Series	Casting	ASTM A351 CF8M-94	0.08	1.5	0.04	0.04	1.5	9 12	18 21	2 3	-	-	-	-	-	70	30	30	-		
	Forging	ASTM A182 Gr. F316 95b	0.08	2.0	0.045	0.03	1.0	10 14	16 18	2 3	-	-	-	-	-	75	30	30	50		
	Forging	ASTM A182 F6a 95b	0.15	1.00	0.04	0.03	1.00	0.50	11.5 13.5						CI.3	110	85	15	35	235 302	
	Bar	ASTM A479 Type 316/95a	0.08	2.0	0.045	0.03	1.0	10 14	16 18	2 3	0.1 N	-	-	-	-		(Ref. Std)		-		

Unless otherwise specified chemical % are maximum mechanical values are minimum

Material Composition (Cont'd)

Noml. Desn.	Form of Matl.	Standard	Chemical - Composition %													Mechanical Properties					Remarks
			C	Mn	P	S	SI	NI	Cr	Mo	AI	Cu	Va	W		T.S (K8l)	Y.S (K8l)	Elgn. %	R.A. %	Hard BHN	
Austenitic Steel 304–CF8 Series	Casting	ASTM A351 CF6-94	0.08	1.5.	0.04	0.04	2.0	8 11	18 21	0.5	-	-	-	-	-	70	30	35	-	-	
	Forging	ASTM A182 F304 95b	0.08	2	0.04	0.03	1.0	8 11	18 20	-	-	-	-	-	-	75	30	30	50	-	(Annealed)
	Bar	ASTM A479 Type 304/95a	0.08	2	0.045	0.03	1.0	8 10.5	18 20	-	0.1 N	-	-	-	-	75	30	30	40	-	
Austenitic Steel 316L–CF3M Series	Casting	ASTM A351 CF3M 94	0.03	1.5	0.04	0.04	1.5	9 13	17 21	2.0 3.0	-	-	-	-	-	70	30	30	-	-	(Annealed)
	Forging	ASTM A182 F316L-95b	0.035	2.0	0.045	0.03	1.0	10 15	16 18	2 3	-	-	-	-	-	70	25	30	50	-	
	Bar	ASTM A479 Type 316L-95a	0.03	2.0	0.045	0.03	1.0	10 14	16 18	2 3	0.1 N	-	-	-	-	70	25	30	40	-	(Annealed)
Austenitic Steel 304L CF8 Series	Casting	ASTM A351 CF3 94	0.03	1.5	0.04	0.04	2.0	8 12	17 21	0.5	- -	-	-	-	-	70	30	35	-	-	
	Forging	ASTM A182 F304L 95b	0.035	2.0	0.045	0.03	1.0	8 13	18 20	-	-	-	-	-	-	70	25	30	50	-	
	Bar	ASTM A479 Type 304L/95a	0.03	2.0	0.045	0.03	1.0	8 12	18 20	-	0.1 N	-	-	-	-	70	25	30	40	-	

Material Composition (Cont'd)

Noml. Desn.	Form of Matl.	Standard	Chemical - Composition %													Mechanical Properties					Remarks
			C	Mn	P	S	SI	NI	Cr	Mo	AI	Cu	Va	W	Fe	T.S (KSI)	Y.S (KSI)	Elgn. %	R.A. %	Hard BHN	
Studs	B7	ASTM A193-95	0.37 0.49	0.65 1.10	0.035	0.04	0.15 0.35	-	0.75 1.20	0.15 0.25	-	-	-	-	-	125 (87.90)	105 (73.84)	16	50	35 RC max	Ora 2-1/2" 8 Under (kgmm²)
	B8	ASTM A193-95	0.08	2.0	0.045	0.03	1.0	8.0 10.5	18 20	-	-	-	-	-	-	-	(Ref Std)				
	L7	ASTM A320-94a	0.38 0.48	0.75 1.0	0.035	0.04	0. 15 0.35	-	0.8 1.1	0. 15 0.25	-	-	-	-	-	125	105	16	50	-	
	B7 M	ASTM A193-95	0.37 0.49	0.65 1.10	0.035	0.04	0.15 0.35	-	0.75 1.20	0.15 0.25	-	-	-	-	-	100	80	18	50	(235 HB) max	
Nuts	2H	ASTM A194-95	0.4 min	1.0	0.04	0.05	0.40	-	-	-	-	-	-	-	-		(Ref. Std.)			248 352	(Hardness 24/38 HRC)
	8	ASTM A194-95	0.08	2.0	0.045	0.03	1.0	8.0 10.5	18 20	-	-	-	-	-	-		(Ref. Std.)			126 300	(Hardness 60 to 105 HRB)
	8M	ASTM A194-95	0.08	2.0	0.045	0.03	1.0	10 14	16 18	2 3	-	-	-	-	-		(Ref. Std.)			126 300	(Hardness 60 to 105 HRB)
	7	ASTM A194-95	0.37 0.49	0.65 1.1	0.04	0.04	0.15 0.35	-	0.75 1.2	0.15 0.25	-	-	-	-	-		(Ref. Std.)			248 352	24-38 HRC
	2HM	ASTM A194-95	0.4 min	1.0	0.04	0.05	0.40	-	-	-	-	-	-	-	-		(Ref. Std.)			159	
HASTALLOY	Casting	ASTM A494 CW 12MW-94	0.12	1.0	0.04	0.03	1.0	Bal.	15.5 17.5	16 18	-	-	0.2 0.4	3.75 5.25	4.5 7.5	72	40	4	-	-	
STEEL	Plate	IS:2062-1992 Gr. A Rev. 4	0.23	1.5	0.050	0.050										410 Mpa	Refer Std.	23			
	Casting	ASTM A439 83(94)-D2	3.0	0.7 1.25	0.08	-	1.5 3.0	18 22	1.75 2.75	-	-	-	-	-	-	58	30	8	-	139 202 HB	
	Forging	ASTM A182 F22(Cl.3)95b	0.05 0.15	0.3 0.6	0.04	0.04	0.5 max	-	2.0 2.5	0.87 1.13	-	-	-	-	-	75 237	45 22 HRC Max.	20	30	156	207

Impa = IN/mm² = 0.102 kg/mm² = 145.04 lbs / In² | 1kg/mm² = 25.4² X 10^{-3} tons/1n² | 1ks1 = 1000 Psi

Unless otherwise specified chemical % are maximum and mechanical values are minimum.

2. Physical Properties of Fluids

Hydrocarbons

NO.	COMPOUND	FORMULA	MOLECULAR WEIGHT	BOILING POINT AT 14.696 psia °F	VAPOR PRESSURE AT 100°F (psia)	FREEZING POINT AT 14.696 psia (°F)	CRITICAL CONSTANTS		SPECIFIC GRAVITY AT 14.696. psia	
							Critical Temperature (°F)	Critical Pressure (psia)	Liquid [3,4] 60°F/60°F	Gas at 60°F (Air=1)[1]
1	Methane	CH_4	16.043	−258.69	(5000)[2]	−296.46[5]	−116.63	667.8	0.3[8]	0.5539
2	Ethane	C_2H_6	30.070	−127.48	(800)[2]	−297.89[5]	90.09	707.8	0.3564[7]	1.0382
3	Propane	C_3H_8	44.097	−43.67	190	−305.84[5]	206.01	616.3	0.5077[7]	1.5225
4	n-Butane	C_4H_{10}	58.124	31.10	51.6	−217.05	305.65	550.7	0.5844[7]	2.0068
5	Isobutane	C_4H_{10}	58.124	10.90	72.2	−255.29	274.98	529.1	0.5631[7]	2.0068
6	n-Pentane	C_5H_{12}	72.151	96.92	15.570	−201.51	385.7	488.6	0.6310	2.4911
7	Isopentane	C_5H_{12}	72.151	82.12	20.44	−255.83	369.10	490.4	0.6247	2.4911
8	Neopentane	C_5H_{12}	72.151	49.10	35.9	2.17	321.13	464.0	0.5967[7]	2.4911
9	n-Hexane	C_6H_{14}	86.178	155.72	4.956	−139.58	453.7	436.9	0.6640	2.9753
10	2-Methylpentane	C_6H_{14}	86.178	140.47	6.767	−244.63	435.83	436.6	0.6579	2.9753
11	3-Methylpentane	C_6H_{14}	86.178	145.89	6.098	...	448.3	453.1	0.6689	2.9753
12	Neohexane	C_6H_{14}	86.178	121.52	9.856	−147.72	420.13	446.8	0.6540	2.9753
13	2,3-Dimethylbutane	C_6H_{14}	86.178	136.36	7.404	−199.38	440.29	453.5	0.6664	2.9753
14	n-Heptane	C_7H_{16}	100.205	209.17	1.620	−131.05	512.8	396.8	0.6882	3.4596
15	2-Methylhexane	C_7H_{16}	100.205	194.09	2.271	−180.89	495.00	396.5	0.6830	3.4596
16	3-Methylhexane	C_7H_{16}	100.205	197.32	2.130	...	503.78	408.1	0.6917	3.4596
17	3-Ethylpentane	C_7H_{16}	100.205	200.25	2.012	−181.48	513.48	419.3	0.7028	3.4596
18	2,2-Dimethylpentane	C_7H_{16}	100.205	174.54	3.492	−190.86	477.23	402.2	0.6782	3.4596
19	2,2-Dimethylpentane	C_7H_{16}	100.205	176.89	3.292	−182.63	475.95	396.9	0.6773	3.4596
20	3,3-Dimethylpentane	C_7H_{16}	100.205	186.91	2.773	−210.01	505.85	427.2	0.6976	3.4596
21	Triptane	C_7H_{16}	100.205	177.58	3.374	−12.82	496.44	428.4	0.6946	3.4596

1.Calculated values.
2. ( ) – Estimated values.
3. Air saturated hydrocarbons.
4. Absolute values from weights in vacuum.
5. At saturation pressure (triple point)
6. Sublimation point.
7. Saturation pressure and 60°F.
8. Apparent value for methane at 60°F
9. Specific gravity, 119°F/60°F (sublimation point).

Hydrocarbons (Cont'd)

NO.	COMPOUND	FORMULA	MOLECULAR WEIGHT	BOILING POINT AT 14.696 psia °F	VAPOR PRESSURE AT 100°F (psia)	FREEZING POINT AT 14.696 psia (°F)	CRITICAL CONSTANTS		SPECIFIC GRAVITY AT 14.696. psia	
							Critical Temperature (°F)	Critical Pressure (psia)	Liquid [3,4] 60°F/60°F	Gas at 60°F (Air=1)[1]
22	n–Octane	C_8H_{18}	114.232	258.22	0.537	–70.18	564.22	360.6	0.7068	3.9439
23	Diisobutyl	C_8H_{18}	114.232	228.39	1.101	–132.07	530.44	360.6	0.6979	3.9439
24	Isooctane	C_8H_{18}	114.232	210.63	1.708	–161.27	519.46	372.4	0.6962	3.9439
25	n–Nonane	C_9H_{20}	128.259	303.47	0.179	–64.28	610.68	332	0.7217	4.4282
26	n–Decane	$C_{10}H_{22}$	142.286	345.48	0.0597	–21.36	652.1	304	0.7342	4.9125
27	Cyclopentane	C_5H_{10}	70.135	120.65	9.914	–136.91	461.5	653.8	0.7504	2.4215
28	Methylcyclopentane	C_6H_{12}	84.162	161.25	4.503	–224.44	499.35	548.9	0.7536	2.9057
29	Cyclohexane	C_6H_{12}	84.162	177.29	3.264	–43.77	536.7	591.	0.7834	2.9057
30	Methylcyclohexane	C_7H_{14}	98.189	213.68	1.609	–195.87	570.27	503.5	0.7740	3.3900
31	Ethylene	C_2H_4	28.054	–154.62	. . .	–272.45[5]	48.58	729.8	...	0.9686
32	Propene	C_3H_6	42.081	–53.90	226.4	–301.45[5]	196.9	669	0.5220[7]	1.4529
33	1–Butene	C_4H_8	56.108	20.75	63.05	–301.63[5]	295.6	583	0.6013[7]	1.9372
34	Cis–2–Butene	C_4H_8	56.108	38.69	45.54	–218.06	324.37	610	0.6271[7]	1.9372
35	Trans–2–Butene	C_4H_8	56.108	33.58	49.80	–157.96	311.86	595	0.6100[7]	1.9372
36	Isobutene	C_4H_8	56.108	19.59	63.40	–220.61	292.55	580	0.6004[7]	1.9372
37	1–Pentene	C_5H_{10}	70.135	85.93	19.115	–265.39	376.93	590	0.6457	2.4215
38	1,2–Butadiene	C_4H_6	54.092	51.53	(20.)[2]	–213.16	(339.)[2]	(653.)[2]	0.658[7]	1.8676
39	1,3–Butadiene	C_4H_6	54.092	24.06	(60,)[2]	–164.02	306	628	0.6272[7]	1.8676
40	Isoprene	C_5H_8	68.119	93.30	16.672	–230.74	(412.)[2]	(558.4)[2]	0.6861	2.3519
41	Acetylene	C_2H_2	26.038	–119.[6]	. . .	–114.[5]	95.31	890.4	0.615[9]	0.8990
42	Benzene	C_6H_6	78.114	176.17	3.224	41.96	552.22	710.4	0.8844	2.6969
43	Toluene	C_7H_8	92.141	231.13	1.032	–138.94	605.55	595.9	0.8718	3.1812
44	Ethylbenzene	C_8H_{10}	106.168	277.16	0.371	–138.91	651.24	523.5	0.8718	3.6655
45	o–Xylene	C_8H_{10}	106.168	291.97	0.264	–13.30	675.0	541.4	0.8848	3.6655
46	m–Xylene	C_8H_{10}	106.168	282.41	0.326	–54.12	651.02	513.6	0.8687	3.6655
47	p–Xylene	C_8H_{10}	106.168	281.05	0.342	55.86	649.6	509.2	0.8657	3.6655
48	Styrene	C_8H_8	104.152	293.29	(0.24)[2]	–23.10	706.0	580.	0.9110	3.5959
49	Isopropylbenzene	C_9H_{12}	120.195	306.34	0.188	–140.82	676.4	465.4	0.8663	4.1498

1.Calculated values.
2. ( ) – Estimated values.
3. Air saturated hydrocarbons.
4. Absolute values from weights in vacuum.
5. At saturation pressure (triple point)
6. Sublimation point.
7. Saturation pressure and 60°F.
8. Apparent value for methane at 60°F
9. Specific gravity, 119°F/60°F (sublimation point).

Other Fluids

FLUID	FORMULA	MOLECULAR WEIGHT	BOILING POINT (°F AT 14.696 PSIA)	VAPOR PRESSURE @70°F (PSIG)	CRITICAL TEMP. (°F)	CRITICAL PRESSURE (PSIA)	SPECIFIC GRAVITY	
							Liquid 60/60°F	Gas
Acetic Acid	$HC_2H_30_2$	60.05	245				1.05	
Acetone	C_2H_6O	58.08	133		455	691	0.79	2.01
Air	N_2O_2	28.97	–317		–221	547	0.86‡	1.0
Alcohol, Ethyl	C_2H_6O	46.07	173	2.3†	470	925	0.794	1.59
Alcohol, Methyl	NH_4O	32.04	148	4.63†	463	1174	0.796	1.11
Ammonia	NH_3	17.03	–28	114	270	1636	0.62	0.59
Ammonium Chloride*	NH_4CI						1.07	
Ammonium Hydroxide*	NH_4OH						0.91	
Ammonium Sulfate*	$(NH_4)_2SO_4$						1.15	
Aniline	C_6H_7N	93.12	365		798	770	1.02	
Argon	A	39.94	–302		–188	705	1.65	1.38
Beer							1.01	
Bromine	Br_2	159.84	138		575		2.93	5.52
Calcium Chloride*	$CaCI_2$						1.23	
Carbon Dioxide	CO_2	44.01	–109	839	88	1072	0.801‡	1.52
Carbon Disulfide	CS_2	76.1	115				1.29	2.63
Carbon Monoxide	CO	28.01	–314		–220	507	0.80	0.97
Carbon Tetrachloride	CCI_4	153.84	170		542	661	1.59	5.31
Chlorine	Cl_2	70.91	–30	85	291	1119	1.42	2.45
Chromic Acid	H_2CrO_4	118.03					1.21	
Citric Acid	$C_6H_8O_7$	192.12					1.54	
Copper Sulfate*	$CuSO_4$						1.17	

Other Fluids (Cont'd)

FLUID	FORMULA	MOLECULAR WEIGHT	BOILING POINT (°F AT 14.696 PSIA)	VAPOR PRESSURE @70°F (PSIG)	CRITICAL TEMP. (°F)	CRITICAL PRESSURE (PSIA)	SPECIFIC GRAVITY	
							Liquid 60/60°F	Gas
Ether	$(C_2H_5)O$	74.12	34				0.74	2.55
Ferric Chloride*	$FeCl_3$						1.23	
Fluorine	F_2	38.00	–305	300	–200	809	1.11	1.31
Formaldehyde	H_2CO	30.03	–6				0.82	1.08
Formic Acid	HCO_2H	46.03	214				1.23	
Furfural	$C_5H_4O_2$	96.08	324				1.16	
Glycerine	$C_3H_8O_3$	92.09	554				1.26	
Glycol	$C_2H_6O_2$	62.07	387				1.11	
Helium	He	4.003	–454		–450	33	0.18	0.14
Hydrochloric Acid	HCI	36.47	–115				1.64	
Hydrofluoric Acid	HF	20.01	66	0.9	446		0.92	
Hydrogen	H_2	2.016	–422		–400	188	0.07‡ •	0.07
Hyrogen Chloride	HCI	36.47	–115	613	125	1198	0.86	1.26
Hydrogen Sulfide	H_2S	34.07	–76	252	213	1307	0.79	1.17
IsopropyI Alcohol	C_3H_8O	60.09	180				0.78	2.08
Linseed Oil			538				0.93	
Magnesium Chloride*	$MgCI_2$						1.22	
Mercury	Hg	200.61	670				13.6	6.93
Methyl Bromide	CH_3Br	94.95	38	13	376		1.73	3.27
Methyl Chloride	CH_3CI	50.49	–11	59	290	969	0.99	1.74
Naphthalene	$C_{10}H_8$	128.16	424				1.14	4.43
Nitric Acid	HNO_3	63.02	187				1.5	
Nitrogen	N_2	28.02	–320		–233	493	0.81‡	0.97
Oil, Vegetable							0.91 –0.94	
Oxygen	O_2	32	–297		–181	737	1.14‡	1.105

• Aqueous Solution - 25% by weight of compound. ‡ Density of liquid, gm/ml at normal boiling point.
†Vapor pressure in psia at 100°F

Other Fluids (Cont'd)

FLUID	FORMULA	MOLECULAR WEIGHT	BOILING POINT (°F AT 14.696 PSIA)	VAPOR PRESSURE @70°F (PSIG)	CRITICAL TEMP. (°F)	CRITICAL PRESSURE (PSIA)	SPECIFIC GRAVITY	
							Liquid 60/60°F	Gas
Phosgene	$COCI_2$	98.92	47	10.7 •	360	823	1.39	3.42
Phosphoric Acid	H_3PO_4	98.00	415				1.83	
Potassium Carbonate'	K_2CO_3						1.24	
Potassium Chloride*	KCI						1.16	
Potassium Hydroxide*	KOH						1.24	
Refrigerant 11	CCI_3F	137.38	75	13.4††	388	635		5.04
Refrigerant 12	CCI_2F_2	120.93	–22	70.2	234	597		4.2
Refrigerant 13	$CCIF_3$	104.47	–115	458.7	84	561		
Refrigerant 21	$CHCI_2F$	102.93	48	8.4	353	750		3.82
Refrigerant 22	$CHCIF_2$	86.48	–41	122.5	205	716		
Refrigerant 23	CHF_3	70.02	–119	635	91	691		
Sodium Chloride*	NaCI						1.19	
Sodium Hydroxide*	NaOH						1.27	
Sodium Sulfate*	Na_2SO_4						1.24	
Sodium Thiosulfate*	$Na_2S_2O_3$						1.23	
Starch	$(C_6H_{10}O_5)x$						1.50	
Sugar Solutions*	$C_{12}H_{22}O_{11}$						1.10	
Sulfuric Acid	H_2SO_4	98.08	626				1.83	
Sulfur Dioxide	SO_2	64.6	14	34.4	316	1145	1.39	2.21
Turpentine			320				0.87	
Water	H_2O	18.016	212	0.9492†	706	3208	1.00	0.62
Zinc Chloride*	$ZnCl_2$						1.24	
Zinc Sulfate*	$ZnSO_4$						1.31	

• Aqueous Solution - 25% by weight of compound. † Vapor pressure in psia.
†Vapor pressure in psia at 100°F

3. SI Units (Systeme Internationale D'Unites)

3.1 Basic SI Units

Quantity	Name of Units	Symbol
length	metre	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
temperature	kelvin	K
luminous intensity	candela	cd

3.2 Supplementary SI Units

plane angle	radian	rad
solid angle	steradian	Sr
Radioactivity	curie	Ci
amount of substance	mole	mol

3.3 Derived Sl Units with special names

Quantity	Name of Unit	Symbol	Definition
force	newton	N	kgm/s^2
stress, strength, pressure	pascal	Pa	N/m^2
dynamic viscosity	poiseuille	PI	Ns/m^2
energy,.work, heat, torque, bending moment	joule	J	Nm
power	watt	W	J/s
absorbed radiation	gray	Gy	J/kg
electric charge	coulomb	C	As
electric potential	volt	V	W/A
electric resistance	ohm	Ω	V/A
electric conductance	Siemens	s	1/Ω
electric capacitance	farad	F	C/V
magnetic flux	weber	Wb	Vs
inductance	henry	H	Vs/A
magnetic flux density	tesia	T	Wb/m^2
luminous flux	lumen	Im	cdSr
illumination	lux	Ix	Im/m^2
frequency	hertz	Hz	cycle/s
temperature	degree celcius	°C	°K-273.15

3.4 Units Belonging to other Systems but used in conjunction with SI

Quantity	Name of Unit	Symbol	Value
length	angstrom	Å	10^{-10}m
area	are	a	10^2m^2
	hectare	ha	10^4m^2
volume	litre	I	$10^{-3}m^3$
time	minute	min	60s
	hour	h	60 min
	day	d	24h
	year	yr	365d
speed, velocity	kilometre per hour	km/h	$\frac{1°}{3.6}$m/s
mass	tonne	t	10^2kg
	quintal	q	m^2kg
angle	degree	(°)	$\frac{\pi}{180}$rad
	minute	(')	$\frac{1°}{60}$
	second	('')	$\frac{1'}{60}$
	grade	g	$\frac{\pi}{200}$rad
angular speed	revolution per minute	rpm	6°/s
	revolution per second	rps	360°/s
force	dyne	dyne	10^{-5}N
pressure	bar	bar	10^5 Pa
dynamic viscosity			
kinematic viscosity			
energy	kilowatt hour	kWh	$3.6x10^6$J
magnetic induction	gauss	G	10^{-4}T

4. Conversion Tables

Quantity	Reference Unit	Equivalent
Length	m	39.37 in, 3.281 ft, 1.0936 yd, $6.214×10^{-4}$mile
	yd	3ft
	ft	12 inch
	inch	2.54 cm
	fathom	6ft
	rod	16.5ft
	mile	1760 yd, 1609.33m, 0.869 n mile
	n mile	1852m, 1.1508 mile
	thou	1.0 mil, $2.54×10^{-5}$m
Area	m^2	1550 in^2,10.764 ft^2, 1.196 yd^2, $2.47×10^{-4}$acre
	mm^2	$1550×10^{-6}in^2$
	in^2	$645.16mm^2$
	ha	1000 m^2, 100 are,
	km^2	100 ha, 10000 are, 247.1acre
		4840 yd^2
	sq.mile	3097600 yd^2, 640 acre. 2.59 km^2
Volume	m^3	1000 I, 61023 in^3, 35.31 ft^3 264.17 US gal. 219.97 Imp. gal
	US gal	3.785 I, 0.8327 Imp. gal
	Imp. gal	4.546 I, 1.201 US gal
	Acre foot	1233.49 m^3
	in^3	16.39 cm^3
Specific Volume	m^3/kg	$16.02ft^3/lb$

Quantity	Reference Unit	Equivalent
Mass	kg	0.0011, 0.01 q. 2.2046 Ib, $1{,}1025×10^3$ Shton. $9.842×10^4$ton
	t (metric)	2204.6 Ib, 1.1025 Sh ton. 0.9842 ton, 1000kg
	Shton	2000 Ib. 0.90721. 0.892857 ton.
	(short)	907.2 kg
	ton (long)	2240 Ib. 1.016t,1 12Shton.1016 kg
	Ib	16oz, $4.536×10^{-1}$ kg
Density	kg/m^3	1.0g/I, 0.001 t/m^3, $3.613×10^{-5}$ Ib/in^3.6.243×10 ^{2}Ib/ft^3. 8.327×10^{-3} Ib/US gal. 10.022×10^{-3}Ib/lmp.gal
Time	yr	365 d, 8760 h
	d	24 h, 1440 min
	h	60 min. 3600 s
	min	60s
Speed, Velocity	m/s	3.6 km/h, 2.237 mile/h, 3.281 ft/s, 196.86 ft/min, 2362.32 in/min, 1.9438 knot
	ft/s	0.3048 m/s. 720 in/min. 1.0973 km/h, 0.6818 mile/h. 0.5925 knot
	km/h	0.2778 m/s, 0.6214 mile/h. 0.54 knot, 0.09113 ft/s. 54.678 ft/min
	mile/h	0.447 m/s. 1.6093 km/h. 0.869 knot. 1.4667 It's, 88 ft/min
Acceleration	m/s^2	3.281 ft/s^2,100gal (galileo)
Plane Angle	rad	$\frac{180.}{\pi}$ 57.3°, 3438' .0.1592 revolution
	degree(°)	60'
	mihute(')	60"

Conversion Tables (Cont'd)

Quantity	Reference Unit	Equivalent
	revolution	6.2832 rad, 360 g(grade)
Solid Angle	Sr	$\frac{1}{4\pi}$ sphere
Angular Speed	rpm	6°/s,
	rps	360°/2, 60rpm
Momentum Angular	kgm/s	7.233 ft lb/s
Momentum Moment of	kgm^2/s	23.73 ft^2/lb/s
Inertia	kgm^2	23.73 ft^2lb
Force	N	1.0 kgm/s^2,0.102 kgf, 0.102 kp (kilopond), 0.2248 lbf, 0.102×10^{-4} tf, 1.0036×10^{4} ton f, 7.233 pdl, $I.0\times l0^{5}$dyne, 1.0×10^{-3}Sn (sthene)
	kgf	9.807 N. 9.807 kgm/s^2,1.0 kp,2.205 Ibf, 70.932 pdl, 9.807×10^{5} dyne
Pressure, Stress, Strength	pa	$1.0N/m^2$,1.0×10^{-5}bar, 0.102×10^{-6} kgf/mm^2,1.45×10^{-4} psi, 6.476×10^{-8} tonf/in^2,10 dyne/cm^2,9.869×10^{-6} atm, 4.015×10^{-3} in H_2O, 0.3349×10^{-3} ft H_2O, 0.102×10^{-3} m H_2O, 0.0075 torr, 0.0075 mm Hg, 2.953×10^{-4} in Hg
	atm	1.013×10^{5}Pa, 1.013 bar, 1.033 kgf/cm^2
Torque	kgm	7.23 lb ft; 3.875×10^{-2} ton in
Rate of Leak (vacuum)	Nm/s	7500 lusec. 75 clusec
Kinematic Viscosity	m^2/s	10.764 ft^2/s, 1.0×10^{4}St
	St	1.0 cm^2/s, 10.764×10^{-4} ft^2/s
Dynamic Viscosity	Pl	1.0 N s/m^2, 10 P, 10 dyne.s/cm^2
		0.102 kgfs/m^2, 20.89×10^{-3} lbfs/ft^2, 7.672 pdls/ft^2
Surface Tension	N/m	0.0057 lbf/in, 1.0×10^{-3} dyne/cm
Temperature	°K	$\frac{5}{9}\times$ °F + 255.2, °C+273.15
	°C	$\frac{5}{9}\times$ °F – 17.78
Temperature Interval	°K	**1×°C,** $\frac{5}{9}$ **× °F**
Energy, Work, Heat, Enthalpy	J	1.0 Nm, 2.778×10^{-7}kWh, 9.482×10^{-4} Btu, 2.3884×10^{-4} kcal, 3.725×10^{-7} Hph, 0.102 kgfm 0.7376 ft Ibf. 23.73 ft pdl, 9.482×10^{-9} Th (therm), 0.2389×10^{-7} hph thermie 3.7767×10^{-7} hph (metric)
	kWh	3.6×10^{6} J. 3.6×10^{6} Nm, 3413 Btu, 860 kca. 1.341 Hph
	Btu	1055 J, 1055 Nm. 0.293×10^{-3}kWh 0.251 kcal. 0.393×10^{-3} Hph
	kcal	4186 J, 4186 Nm, 1.163×10^{-3} kWh 3.964Btu,1.559×10^{-3} Hph
	Hph	2.685×10^{6}J, 2.685×10^{6}Nm, 0.7457 kWh, 2545 Btu, 641.3 kcal
Heat Capacity Entropy	J/°K	1.0J/°C, 0.2389 cal/°C, 5.267×10^{-4} Btu/°F

Conversion Tables (Cont'd)

Quantity	Reference Unit	Equivalent
Specific Heat Capacity, Specific Entropy	J/kg-K	1.0 J/kg°C, 0.2389×10^{-3} kcal/kg°K 0.2389×10^{-3} Btu/lb°F, 0.4536 J/lb°K
Specific Energy, Specific Latent Heat, Specific Calorific Value Specific Enthalpy	J/kg	0.2389×10^{-3} cal/g, 4.3×10^{-4} Btu/b
Calorific Value (volume), Specific Enthalpy	J/m^3	0.2389 cal/m^3, 0.2389×10^{3} kcal/m^3, 2.685×10^{-5} Btu/ft^3
Power, Energy Flow Rate	W	1.0 J/s, 1.0×10^{-7} erg/s, 0.2386 cal/s, 0.8598 kcal/h, 3.413 Btu/h, 0.102 kgfm/s,0.102kpm/s, 1.341×10^{-3} Hp (FPS), 1.36×10^{3} hp (metric), 0.7376 ftlbf/s
	kcal/h	1.163 W, 1.163 J/s, 0.2778 cal/s, 0.1186 kgfm/s, 3.97 Btu/h, 0.1186 kpm/s, 0.8579 ft Ibf/s, 1.5817×10^{-3} hp (metric), 1.56×10^{-3} Hp (FPS)
	Btu/h	0.293 W, 0.293 J/s, 0.07 cal/s, 0.2519 kcal/h, 0.0299 kgfm/s, 0.0299 kpm/s, 0.216 ft Ibt/s, 3.9847×10^{-4} hp (metric), 3.929×10^{-4} Hp (FPS)
	ftlbf/s	1.356 W, 1.356 J/s, 0.3239 cal/s, 1.1657 kcal/h, 4.627 Btu/h, 0.1383 kgfm/s, 0.1383 kpm/s, 1.844×10^{-3} hp (metric), 1.818×10^{-3} (FPS)
	Hp(FPS)	745.7 W, 745.7 J/s, 178.15 cal/s, 641.16 kcal/h, 2545 Btu/h, 76.06 kgfm/s, 76.06 kpm/s, 550 ftlbf/s, 1.014 hp (metric)
Density of Heat Flow Rate	W/m^2	1,0J/m^2s,6.45×10^{-4} W/in^2, 0.2389×10^{-4} cal/cm^2s, 0.8598 kcal/m^2h, 0.3171 Btu/ft^2h
	W/in^2	1550 W/m^2, 1550 J/m^2s, 0.037 cal/cm^2s, 1333 kcal/m^2h, 491.6 Btu/ft^2h
	cal/cm^2s	4.186×10^{4}W/m^2, 27W/in^2, $4{,}186\times10^{4}$J/m^2s, 36.0×10^{3} kcal/m^2h, 1.327×10^{4} Btu/ft^2h
	$kcal/m^2h$	1.163 W/m^2, $7.5x10^{-4}$ W/in^2,1.163 J/m^2s, $0.2778x10^{-4}$ cal/cm^2s, 0.3688 Btu/ft^2h
	Btu/ft^2h	3.15W/m^2, $2.03x10^{-3}$W/in^2, 3.15 J/m^2s, 0.7534x 10^{-4} cal/cm^2s, 2.7114 kcal/m^2h
Thermal Conductivity	W/m°C	0.5278 Btu/fth°F, 2.389x 10^{-3} cal/cms°C, 0.8598 kcal/mh°C, 0.3048 W/ft°C
	Btu/fth°F	1.895 W/m°C, 0.577 Wm°C. 4.526×10^{-3} cal/cms°C, 1.629 kcal/mh°C

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Conversion Tables (Cont'd)

Quantity	Reference Unit	Equivalent
Heat Transfer Coefficient	$W/m^2°C$	0.1761 Btu/ft^2F, $0.2389x10^{-4}$ $cal/cm^2s°C$, 0,8598 $kcal/m^2h°C$, 0.0929 W/ft°C
	$Btu/ft^2h°F$	5.6786 $W/m^2°C$, 0.5275 W/ft^2C, $0.1357x10^3$ $cal/cm^2s°C$, 4.882 $kcal/m^2h°C$
Quantity of Electricity,	C	1.0AS, $2.778x10^4$ Ah, $1.036x10^{-5}$ Faraday,
Electric Charge		0.1 ab-C, $2.998x10^9$ stat-C
Electric Current	A	0.1 ab-A, $2.998x10^9$ stat-A
Electric Potential	V	$1.0x10^8$ ab-V, 3.336x10 ^{2}stat-V
Electrical Resistance	ohm(Ω)	$1.0X10^9$ ab-ohm, $1.113x10^{-12}$ stat-ohm
Electrical Resistivity	ohm-metre	$1.0x10^2$ ohm-cm, $1.0x10^{11}$ ab-ohm-cm, $1.113X10^{-10}$ stat-ohm-cm
Capacitance	F	1.0C/V,$1.1.0X10^{-9}$ ab-F, $8.987X10^{11}$ stat-F
Magnetic Flux	Wb	1.0 Vs,$1.0x10^8$ Maxwell, $1.0x10^5$ kiloline
Inductance	H	1.0 Vs/A, $1.0x10^9$ ab-henry, $1.113X10^{-12}$ stat-henry
Magnetic	T	1.0 Wb/m^2, $1.0x10^4$G, 64.52 kiloline/m^2
Flux Density, Magnetic Induction		
Magnetic Potential	amp-turn	1.257 gilbert, 0.1 ab-amp-turn
Magnetic Field Strength	amp-turn/m	$1.257x10^{-2}$ oersted, $2.54x10^{-2}$ amp-turn/in,$I.0x10^{-3}$ab-amp-turn/cm
Luminance	cd/m^2	0.0929 cd/ft^2,0.2919 ft lambert
Luminous Flux	lumen	1.0 cd/Sr
Illumination	Ix	0.0929 lm/ft^2, 0.0929 ft candle
Mass Flow	kg/h	1.67x 10^{-2} kg/min, 3.68 Ib/min. $l.102x10^{-3}$Sh ton/h, $9.84x10^{-4}$ ton/h
Volumetric Flow	l/s	3.6 m^3/h,13.2Imp-gpm$3.531x10^{-2}$cusec.
Concentration	ppm	00584grain/USgal, 1 mg/l, 0.0701
Hardness of Water		grain/Imp gal, 8.345 Ib per million gal 0.07 British degree 0.058 American degree 0.010 French degree 0.056 German degree 0.40 Russian degree

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