TECHNICAL
HANDBOOK

BHANDARI

BHANDARI METAL SYNDICATE
BHANDARI METAL INDUSTRIES

Contents

Company Profile

Established in the year 1985, **Bhandari Metal Syndicate** is based in Chennai, India. The company has set benchmarks of excellence in the arena of supplying ferrous and non-ferrous metal serving an assortment of industries. Our specialization lies in a bouquet of products in which we have carved a niche as one of the leading stockist, importers and suppliers of stainless steel coils, plates, sheets, pipes, bars & fittings. Growing tremendously in the domain, we have established imprints in the minds of global clients by serving them with superior quality products. Moreover, under the astute guidance of our chairman **Mr. D.Deepak Bhandari**, we have established an indelible place in the buoyant market economy.

Catering to Different industrial sections, we have managed to uphold our position amongst the topmost business players in stainless steel market. With the motive to excel in professional endeavour, we have established good contact with reliable manufacturing companies in india and worldwide. Our penchant is to render in the absolute satisfaction to customer, we assure to provide quality products and expedite service.

Our clients are spread throughout india and are from wide range of industries such as; Chemicals, Petrochemicals, Railways, Cements, Fertilizers, Refinery Engineering, Paper and Pulp, Electricals , Nuclear Power, Sugar, Pumps & valves, Interior decorators, General fabricators and many other large Industries.

We maintain a huge inventory of all products ranges in afully equipped, well furnished warehouse, with technicians deployed for expert handling of the material.
The young and dynamic entrepreneurs behind "**BHANDARI**" are strong believers in maxim:

'Only absolute quality and competitive price drives Business'

We believe that we can have smile on our lips only when we bring smile on your lips.
Give us an opportunity to make you and your business to smile.

QUALITY POLICY

- To strive for customer satisfaction by service and Technological Integration.
- All departments are fully automized for better supply chain management to offer best product quality & prompt service to customers.
- To train, motivate and encourage employees in achieving company's goals.
- All our products pass through best of quality systems for material control, process control, testing, finishing and marking.
- Create a sense of responsibility amongst all members of the organization.
- To maintain a competent work force through training and continual improvement of quality management skills.
- Continually improve our quality management system to ensure its continuing suitability to enable us to stay ahead of competition.

Product Range - General

Stainless Steel Pipes & Tubes
Seamless & ERW, in AISI 201, 202, 304, 304L, 316, 316L, 321 & 310 Grades.

Stainless Steel
All types of fitting elbow, tee, stubend, reducer, flange, union, coupling, bends etc. All the items are available in all grades of **Stainless Steel**

Stainless Steel sheets & coils
AISI 201, 202, 301, 304, 304L, 316, 316L, 317, 317L, 310, 321, 409, 410, 420, 430, 409m, 436, 439 among others.

Stainless steel rods
Magnetic & Non-magnetic rods in AISI 201, 202, 304, 304L, 310, 316, 316L, 410, 420 and other Grades size of all the rods available in square & hexagonal shapes.

Stainless steel wire, strips, flats & circles, round rod, square rod & hexagon rods (A/F) & Shims
All the above items are available as per customer's required size and specification in all the grades 201, 202, 301, 304, 304L, 316, 316L, 310, 409, 410, 430.

Copper Sheets, Plates, Tubes, Flats, Strips & Wires :
High conductivity, free machining Rods, Electrolytic & commercial quality strips Wires, Refrigeration Copper Tubes, Plates & Sheet in imported & Indigenous make.

Brass Tubes, Rods, Plates Strips & Wire
BSS & ISS Grade, Naval Brass Rods, 70/30 Sugar Tubes, Flats & Strips in all sizes. Round, Square and Hexagonal Brass Rods available from ready stocks.

Phospher Bronze Rods, Sheets & Plates
Spring Hard Quality imported & Indigineous in Rolls & Plates are available in standard sizes.

Stainless Steel Valves
Stainless Steel, Gate Valve, Globe Valve, Plug Valve, Butterfly Valve and other valves suitable for Dairy, Food & Pharmaceuticals and many other industries.

Aluminium
Rods, Sheets, Plates, Strips, Flats, Wires, Pipes, Rolls, Circles, Rectangular, Hexagonal bars fittings etc. in all grades.

Virgin Metals
White Metal, Gun Metal, Tin, Solder Antimony & all other Virgin Metals.

Monel & Nickel Alloy
Monel, Nickel, Inconel Rods, Sheet, Pipes.

Ingots
Copper, Aluminium, Phosphor, Bronze, Gun Metal, Zinc, Lead, White Metal, Antimoni, Copper.

Casting Bushes
Gun Metal, Phospher, Bronze, Copper in all shapes and dimensions.

Alloy & Tool Steels
EN8,9,19 & 24, 36 High Carbon & High Chromium, Silver Steel, Die Steel, Carbon Steel, Mild Steel Bright Bars etc. in shapes of Round, Square, Rectangular, Triangle, Flats & Circles.

Channels & Angles
Available in Stainless Steel, Brass, Aluminium & Mild Steel, Original & Plate Bended items are available as per customer's specification and grade.

Perforated Sheets
Available in Mild Steel, Stainless Steel, Brass & Copper. Useable for sugar industries, Fertilizers & Chemicals & Paper in all sizes and grades.

Fastners
Available in Copper, Brass, Stainless Steel & Mild Steel as per customer's requirement.

Instrumentation Fittings
(NPT/BSP/BSPT) Flareless Fittings in Stainless Steel (Male/Female) union, Adaptor, Reducing Tee & Elbow.

Cupronickel Pipes and Tubes
Cupronickel Tubes are available in all sizes & as per the length required by the customer.

Notes
If you require any non-standard sizes, we shall undertake the job for manufacturing and/or supplying such material and the same will be done at the lowest price. The material shall be supplied correctly as per your required size and specification, your detailed technical data/drawing for those items are welcome along with your valued enquiries.

Product Range - Stainless Steel

Stainless Steel is available in a variety of forms. We have a ready stock of the following product range :

S.No.	Product Description	Thickness (mm)	Width (mm)	Length (mm)
1.	S.S. Foils	0.05-0.50	50-600	Any Length
2.	S.S. Coils	0.20-12.0	600-2500	Any Length
3.	S.S. Sheets	0.40-4.0	900-2000	Any length
4.	S.S. Plates	4.00-100.0	1000-2500	Any Length
5.	S.S. Strips	0.20-3.0	9-600	Any Length
6.	S.S. Flats	3.0-50.0	Any width	Any Length
7.	S.S. Pipes	0.5-25.0 (Wall)	3.0-610.0 (O.D.)	Any Length
8.	S.S. Wires	0.05-6.0 (Ø)	-	Any Length
9.	S.S. Rods	2.0-400.0 (Ø)	-	Any Length
10.	S.S. Rounds	0.10-50.0(Ø)	10-2000(Ø)	-
11.	S.S. Flanges	Any size	Any size	Any size
12.	S.S. Channels	Any size	Any size	Any size
13.	S.S. Angles	Any size	Any size	Any size
14.	S.S.Pipe Fittings	Any size	Any size	Any size
15.	S.S. Balls	Any size	Any size	Any size
16.	S.S. Rings	Any size	Any size	Any size

- Plastic Coated Sheets also available.
- Titanium coated colour sheets also available.
- Any special item can be provided with mutual discussion.
- Any specific tolerances can be provided with mutual discussion.
- Any non-standard size can be made available with mutual discussion.

Characteristics of Stainless Steels

The characteristics of stainless steels can be viewed as compared to the more familiar mild steel. As a generalisation the stainless Steel exhibit the following characteristics:

(Applicable particularly to the austenitic family and to varying degrees to other grades)

Higher corrosion resistance
Lower alloyed grades resists corrosion in atmospheric and pure water environments, while high-alloyed grades can resist corrosion in most acid, alkaline solutions and chlorine bearing environments.

Fire and heat resistance
Stainless Steel resists scaling and retains strength at high temperatures.

Strength to weight advantage
The work-hardening property of austenitic grades that results in a significant strengthening of the material from cold-working alone and the high strength duplex grades allow reduced material thickness over conventional grades and therefore saves cost.

Toughness and impact resistance
The austenitic micro structure of the 300 series provides high toughness, from elevated temperatures to far below freezing, making these steels particularly suited to cryogenic applications.

Ease of fabrication
Modern steel-making techniques mean that stainless steel can be cut, welded, formed, machined and fabricated as readily as traditional steel.

Hygiene
The easy cleaning ability of stainless steel makes it the first choice for strict hygiene conditions such as hospitals, restaurants, kitchens, abattoirs and other food processing plants.

Aesthetic appearance
The bright, easy to maintain surface of stainless steel provides a modern and attractive appearance.

Low maintenance cost
Stainless steel does not need additional systems to protect the base metal as the metal itself will last. Stainless steel products complete their service life. There is less concern about disposal since this material is 100% recyclable.

Long term value
When the total life cycle costs are considered, stainless steel is often the least expensive option as the material can withstand the action of environment and requires less maintenance. It also is a completely recyclable material.

History of Stainless Steel

Stainless Steel was invented in 1912 by an English metallurgist named Harry Brearley while trying to develop an alloy that would protect cannon bores from erosion. The first true stainless steel was melted on the 13th August, 1913.

Why is Stainless Steel 'Stainless'

Stainless steel are iron-based alloys containing a minimum of about 10.5% chromium; this forms a protective self-healing oxide film which is the reason why this group of steels have their characteristic 'Stainlessness' or corrosion resistance. The ability of the oxide layer to heal itself means that the steel is corrosion resistant, no matter how much of the surface is removed. This is not the case when carbon or low alloy steels are protected from corrosion by metallic coatings such as zinc or cadmium or by organic coatings such as paint.

Typical characteristics and applications of Stainless Steel

AISI Types	Characteristics	Typical Application
	AUSTENITIC	
302	General purpose stainless steels.	Widely used for severely formed parts.
304	General purpose stainless steel specially for welded construction.	For welded construction and heavy wall vessels formed in a number of draws.
304L	Low carbon modification of type 304, resists carbide precipitation during welding.	For welded construction ensuring superior results in overcoming the problem of carbide precipitation in the weld zone without post annealing. Can be used in range of 420°C-820°C for upto 4 hrs. without becoming susceptible to intergranular corrosion.
321	Stabilised 18/8 type with titanium; not sensitive to intergranular corrosion within the carbide precipitation range of 420° to 870°C, corrosion resistance comparable to 304.	Used in oxidising corrosive environments within 420°C to 870° C for welded construction. No annealing required after welding.
347	Stabilised 18/8 type with columbium. Corrosion resistance comparable to type 304.	Used within 420°-870°C for welded construction. No annealing required after welding.
316	High creep strength, superior corrosion resisting properties in reducing atmosphere.	Used in industries with medias such as Sulphurous acid, Sulphuric acid, phosphoric acid, formic acids & various acids for better corrosion resistance that 18/8 type.
316L	Low carbon modification of 316.	Used in place of 316 for maximum corrosion resistance properties. Applied when annealing after welding is impossible.
310	Excellent high temperature properties with good ductility & weldability.	Used upto 1150°C for continuous service & 1050° for intermittent service in oxidising atmosphere.
	FERRITIC	
430	Good combination of corrosion resistance, useful mechanical properties & good formability. Not hardenable by heat treatment.	Utensils, hardwares, fasteners, appliances, furnace parts, Nitric acid processing equipments etc.
	MARTENSITIC	
403	12% Cr ensuring high degree of cleanliness, hardenable by heat treatment.	Reactor components, turbine blades and rings & other highly stressed parts.
410	General purpose corrosion & heat resisting steel; gives maximum corrosion resistance after heat treatment. Hardenable by heat treatment.	Cutlery, Shafts, Cracking tower, bubbler caps & trays for oil & gas industry, beater bars for paper & pulp industries etc.
420	Good ductility in annealed condition; hardenable to highest hardness of all 12% Cr types; gives best corrosion resistance properties in hardened, ground or polished condition.	Cutlery, surgical instruments, valves etc.

* Austenitic stainless steels are not hardenable by heat treatment. These can be hardened by cold work only.

Applications

AISI 301
An austentic stainless steel, because of its ability to attain high strength and ductility through moderate or severe cold working, can be used for automobile trims, conveyor belts, transportation cars such as railways coaches, metal fixtures for construction purposes, roof drainage products, strong door frames, tableware etc.

AISI 304
It is the most widely used austentic stainless steel. It exhibits excellent corrosion resistance and forming characteristics. It is widely used in petrochemical and fertilizer industries, dairy product processing equipments, food processing, pharmaceutical industries, hospitals, kitchenware, sinks, cutlery, cryogenic vessels, as heat exchanger in air conditioning, refrigeration, textile machinery, distilleries among others.

AISI 304L
An austentic stainless steel similar to AISI 304 but with less carbon (0.03%). It is used in the place of AISI 304 for improved resistance to inter-granular corrosion and in applications where structures cannot be heat treated for stress relieving after welding.

AISI 309 / AISI 309S
These are austentic stainless steels which are strong and tough. Because of their higher nickel and chromium content, they are used for applications requiring high scaling and corrosion resistance. They find their use for air heater, annealing boxes, boiler baffle plates, carburizing boxes, chemical processing equipment, dryers, exhaust manifolds, furnace parts, gas turbine parts and refinery equipments.

AISI 310 / AISI 310S
These are austentic types with higher chromium and nickel content when compared to AISI 309. Because of their relatively high creep strength and mechanical properties exhibited at higher temperatures. These steel find their applications in higher temperatures and severe service conditions. Used for air heaters, annealing boxes, ovens, carburizing boxes, fire box sheets, furnace linings, furnace stacks and dampers, gas turbine parts, heat exchanger, kiln linings, nozzle diaphragm assemblies for turbo jet engines, oil burner parts, oil refinery equipment, recuperators etc.

AISI 316
Yet another popular austentic stainless steel with 2 to 3% molybdenum. Molybdenum improves corrosion resistance and imparts hot strength characteristics. It is used in applications requiring resistance to pitting corrosion and in halogen atmospheres. Typical applications include architectural trims, marine exteriors, chemical processing equipments, food processing equipments, petroleum refining equipments, pharmaceutical equipments, photography equipments, pulp and paper processing equipments, tannery equipments etc.

AISI 316L
A variation of AISI 316, contains maximum of 0.03% carbon, with reduced tendency towards carbide precipitation without addition of a stabilizing element. It is recommended for parts which cannot be heat treated, post welding.

AISI 317/317L
These are modifications of AISI 316/316L. With increased chromium, nickel and molybdenum content, they offer greater corrosion resistance. The steels were developed to resist attack of sulphurous acid compounds. They exhibit resistance against phosphoric and acetic acids. Applications include paper pulp handling equipments, process equipments for producing photographic chemicals and bleaching solutions, handling sulphurous, acetic, formic, citric and tartaric acids. They have the best corrosion resistance to body acids and blood and are recommended for surgical bone applications.

AISI 321
An austentic stainless steel it is similar to AISI 304 but stabilized with titanium to avoid inter-granular corrosion. It resists scaling and vibration fatigue. It is used for aircraft exhaust stacks, pressure vessels, large mufflers for stationary diesel engines, carburetor, expansion bellows, stack liners, fire walls etc.

AISI 347
An austentic stainless steel similar to AISI 321 but stabilized by columbium which does not appreciably reduce the overall corrosion resistance. It is recommended in the range of 240°C to 900°C for parts fabricated by welding and which cannot be subsequently annealed. Applications include airplane exhaust stacks, welded tanks for chemicals, heat resistors, jet engine parts, expansion bellows etc.

AISI 409/409M
It is the lowest alloyed straight Ferritic stainless steel. It replaces carbon steels and low alloy steel where some amount of heat and corrosion resistance and higher strength is required. It is used for fins in heater tubes, transformer and capacitor cases, dry fertilizer spreaders, automotive exhaust systems including mufflers, resonators, silencer pipes and emission control units, high pressure agricultural spray tanks, culverts, shipping containers, farm equipments etc.

Applications

AISI 410/410S

AISI 410 is the most commonly used 12% chromium martensitic stainless steel. Excellent combination of toughness and strength can be developed through proper heat treatment. This steel has better corrosion resistance in the hardened condition. It is a good choice when good formability and high strength are required and the end use demands resistance to mildly corrosive environment. It is used for furnace parts and burners operating below 650°C, micrometer parts, tray supports, caps and vaporizers in petroleum fractionating towers, lining for reaction chambers, coal screens, fishing tackles, keys, lamp brackets, rules and tapes, wall screens, steam turbine buckets, blades, bucket covers, pump parts and press plates. AISI 410S is a low carbon variant of AISI 410.

AISI 420

This martensitic steel contains 0.15% C and 12% Cr. It can be thermally hardened to develop very high strength. Chiefly used for cutlery, vegetable choppers, scissors, shears, tweezers, hand tools, dental and surgical instruments etc.

AISI 430

It contains 17% Cr and is inferior to AISI 304 as regards deep drawability. It is used under less severe corrosive atmospheres for chemical processing equipment, furnace parts, heat exchanger, oil burner parts, petroleum rolling equipment, protection tubes, recuperators, rubber plant machinery, storage vessels, tubing, television cones, air conditioners, washing machine parts and decorative trims.

Surface Finishes

Surface finish is an important element in any specification for stainless steel. SSSS offers you a wide range of finishes with expert guidance on which finish would be best suited for your application.

Hot Rolled

No.1 Finish : Slabs are hot rolled to plate/coils, annealed shot blasted and pickled. This results in a dull, slightly rough surface; quite suitable for industrial application.

Cold Rolled

2D Finish : Material with no.1 finish is cold rolled, annealed and pickled. This results in a dull but superior finish, when compared to No.1 finish. It is suitable for severe deep drawing as the dull surface retains the lubricant during the drawing operation.

2B Finish : Material with 2D finish is given a subsequent light skin pass operation between polished rolls. It is brighter than 2D and is semi-reflective.

No.3 Finish : This is a ground unidirectional uniform finish obtained with 100-120 grit abrasive. It is a good intermediate finish for surfaces which would require finer finish after the fabrication/forming process.

No.4 Finish : This is a ground unidirectional uniform finish obtained with 120-150 grit abrasive. It is not highly reflective but is suited for components which would suffer from rough handling.

BA Finish : Annealing is done in a controlled atmosphere of cracked ammonia to avoid any oxidation of metal which ensures a bright finish called BA finish. The final surface developed will have a MIRROR type finish. Strips processed through bright annealing line have a brighter luster than material conventionally annealed and pickled.

No8. Finish : This is the most reflective finish obtained by polishing with rotating cloth mops and polishing soaps/paste containing fine abrasives.

Special Finishes Chequred, Moon Rock, Striped Finish

These are typical rolled finishes produced by using an etched roll in the final pass in cold reduction.

Matt Finish : This is produced by using a specific rough ground roll during skin passing of 2D Finish material. It offers a matt surface with least reflectivity.

Note : *Any specific finish requirements can be supplied with mutual discussion.*

Equivalent Standards

Grade	USA-Canada/ AISI-ASTM - ASME	India/IS Letter Symbol Numerical	INDIA/IS Letter Symbol INDIA/IS Symbol (ISS)	UNS Designa-tion	DIN Germany	UNI Italy	Japan JIS	USSR/ Gost
301	301	X10Cr17Ni7	301	S30100	1,4310	X12CrNi1707	SUS301	
304	304	X04Cr19Ni9	304Sl/30482	S304000	1,4301	X5CrNi1810	SUS304	08Ch18N10
304H	304H			S30409				
304L	304L			S30403	1,4306	X2CrNi1911	SUS304L/SCS19	03Ch18N11
304LN	304LN			S30453	1,4307	X2crNiN1810	SUS304LN	
309	309	X15Cr24Ni13	309			X15CrNiSi2012	SUH309	20Ch20NS2
309S	309			S30908		X7CrNi2314	SUS309S	
310	310	X20Cr25Ni20	310			X15CrNiSi2520	SUH310	20Ch25N20S2
310S	310S			S31008	1,4845	X12CrNi2521	SUS310S	20Ch23N18
316	316	X04Cr17Ni12Mo2	316	S31600	1,4401	X5CrNiMo17122	SUS316	
316L	316L	X02Cr17Ni12Mo2	316L	S31603	1,4404	X2CrNiMo18143	SUS316L/SCS163	3Ch17N14M3
316LN	316LN			S31653	1,4406	X2CrNiMoN17133	SUS316LN	
316Ti	316Ti	X04Cr17Ni12Mo2Ti	316Ti	S31635	1,4571	X6CrNiMoTi17122		10Ch17N13M2T
317	317			S31700		X5CrNiMo17133	SUS317	
317L	317L			S31703	1,4438	X2CrNiMo18164	SUS317L	
317LN	317LN			S31753				
321	321	X04Cr18Ni10Ti	321	S32100	1,4541	X6CrNiTi1810	SUS321	08Ch18N10T
347	347	X04Cr18Ni10Nb	347	S34700		X6CrNiNb1810	SUS347	08Ch18N12B
409	409			S40900	1,4512	X6CrTi12		
410	410	X12Cr12	410	S41000	1,4006	X10Cr13	SUS410	
410S	410S			S41008	1,4000			
430	430	X07Cr17	430	S43000	1,4016	X6Cr17	SUS430	
430Ti	430				1,4510	X6CrTi17	SUS430LX	

Chemical Composition

Grade	C% Max	Mn%	P%	S%	Si%	Cr%	Ni%	Mo%	N%	Others
SSLN 1	0.08 - 0.11	9.00 - 9.75	0.06	0.016 Max	0.6 Max	15.00 - 15.70	1.00 - 1.70	-	0.13 - 0.16	Cu=1.73 - 2.00
SSLN 4	0.05 - 0.08	6.75 - 7.50	0.06 Max	0.015 Max	0.6 Max	16.00 - 16.70	4.00 - 4.70	-	0.08 - 0.11	Cu=1.60 - 2.00
301	0.15	2.00	0.045	0.03	1.00	16.00 - 18.00	6.00 - 8.00	-	0.10	-
304	0.08	2.00	0.045	0.03	0.75	18.00 - 20.00	8.00 - 10.50	-	0.10	-
304H	0.04 - 0.10	2.00	0.045	0.03	0.75	18.00 - 20.00	8.00 - 10.50	-	-	-
304L	0.030	2.00	0.045	0.03	0.75	18.00 - 20.00	8.00 - 12.00	-	0.10	-
304LN	0.030	2.00	0.045	0.03	0.75	18.00-20.00	8.00 - 10.50	-	0.10 - 0.16	-
309	0.20	2.00	0.045	0.03	0.75	22.00 - 24.00	12.00 - 15.00	-	-	-
309S	0.08	2.00	0.045	0.03	0.75	22.00 - 24.00	12.00 - 15.00	-	-	-
310	0.25	2.00	0.045	0.03	1.50	24.00 - 26.00	19.00 - 22.00	-	-	-
310S	0.08	2.00	0.045	0.03	1.50	24.00 - 26.00	19.00 - 22.00	-	-	-
316	0.08	2.00	0.045	0.03	0.75	16.00 - 18.00	10.00-14.00	2.00 - 3.00	0.10	-
316L	0.030	2.00	0.045	0.03	0.75	16.00 - 18.00	10.00 - 14.00	2.00	0.10	-
316LN	0.030	2.00	0.045	0.03	0.75	16.00 - 18.00	10.00 - 14.00	2.00	0.10	
316Ti	0.08	2.00	0.045	0.03	0.75	16.00 - 18.00	10.00 - 14.00	2.00	0.10	Ti=5X(C+N) Min., 0.70 Max.
317	0.08	2.00	0.045	0.03	0.75	18.00 - 20.00	11.00 - 15.00	3.00	0.10	-
321	0.08	2.00	0.045	0.03	0.75	17.00 - 19.00	9.00 - 12.00	-	0.10	Ti=5X(C+N) Min.,
347	0.08	2.00	0.045	0.03	0.75	17.00 - 9.00	9.00 - 13.00	-	-	Ch=10XC Min., 1.00 Max.
409	0.030	1.00	0.040	0.02	1.00	10.50 - 11.75	0.50 Max	-	0.03	Ti=6X(C+N) Min., 0.75 Max.
409M	0.03	0.80 - 1.50	0.03	0.03	1.00	10.80 - 12.50	1.50 Max.	-	0.03	Ti=0.75 Max.
410	0.15	1.00	0.040	0.03	1.00	11.50 - 13.50	0.75 Max	-	-	-
410S	0.08	1.00	0.040	0.03	1.00	11.50 - 13.50	0.60 Max	-	-	-
430	0.12	1.00	0.04	0.03	1.00	16.00 - 18.00	0.75 Max	-	-	-
430 Ti	0.030	1.00	0.04	0.03	1.00	16.00 - 19.00	-	-	-	Ti=010 - 1.0
436	0.12	1.00	0.040	0.03	1.00	16.00 - 18.00	-	0.75 - 1.5	-	Cb=5X C Min., 0.80 max
420	0.15 min	1.00	0.040	0.03	1.00	12.00 - 14.00	0.75 Max	-	-	Mo=0.50 Max.

Mechanical Properties of Stainless Steel

Grade	UTS N/mm^2 (Min.)	0.2% Proof Stress N/mm^2(min.)	% Elongation on 50% GL (Min.)	Hardness RB (max)
301	515	205	40	95
304	515	205	40	92
304L	485	170	40	92
310S	515	205	40	95
316	515	205	40	95
316L	485	170	40	95
321	515	205	40	95
409	380	205	20	88
409M	450	275	20	90
410S	415	205	22	89
430	450	205	22	89

Note : Material with specific mechanical properties can be provided with mutual discussion.

Physical Properties : CRSS

Property	301	304	316	310S	430	409
Density (gm/cm^3)	7.9	7.9	8.0	7.9	7.7	7.7
Modulus of Elasticity (Kg/mm^2)	19700	19700	19700	20300	20300	20300
Specific Heat Capacity (Cal/gm/°C)	0.12	0.12	0.12	0.12	0.11	0.11
Thermal Conductivity (Cal/cm^{2}sec/°C/cm at 100°C)	0.039	0.039	0.0373	0.033	0.0625	0.0595
Specific Electrical Resistance (mW/cm)	72	72	74	80	60	57
Melting Range (°C)	1400-1420	1400-1455	1370-1400	1400-1455	1430-1510	1430-1510
Magnetic	Non Magnetic	Non Magnetic	Non Magnetic	Non Magnetic	Ferro Magnetic	Ferro Magnetic

Note : Material with specific physical properties can be provided with mutual discussion.

Dimensional Tolerances

Normal Tolerances on Thickness (Width upto 1500 mm)
Cold Rolled

Thickness (mm)	Tolerance (±) mm
0.30 to < 0.60	0.05
0.60 to < 0.80	0.07
0.80 to < 1.00	0.09
1.00 to < 1.25	0.10
1.25 to < 1.60	0.12
1.60 to < 2.00	0.15
2.00 to < 2.50	0.17
2.50 to < 3.15	0.22
3.15 to < 4.00	0.25
4.00 to < 6.00	0.25

Normal Tolerances on Thickness (width upto 1500 mm)
Hot Rolled

Thickness (mm)	Tolerance (±) mm
2.00 to < 2.25	0.18
2.25 to < 2.50	0.20
2.50 to < 2.75	0.23
2.75 to < 3.00	0.25
3.00 to < 3.25	0.25
3.25 to < 3.50	0.30
3.50 to < 3.75	0.30
3.75 to < 4.00	0.36
4.00 to < 4.99	0.36
4.99 to < 5.00	0.36

- *For thickness above 5.00 mm the applicable tolerance would be 5-8% of the thickness.*
- *Thickness measurement are taken at 20mm from the edge.*
- *The above tolerances are applicable both for sheets and coils.*

Tolerances on Length

Upto 4 mm thickness	+10 mm
Beyond 4 mm thickness	+30 mm

***Note** : The above tolerances are applicable for sheets and plates only.*

Selection of welding processes of stainless steel

Welding Method	Recommended Thickness (mm)	Austentic	Weldability Ferritic	Martensitic
Shield Metal Arc Welding (SWAW)	>0.8	Easy to weld	can be welded with care	Difficult to weld Requires Special Care
Gas Tungsten Arc Welding (GTAW)	<3.0	Easy to weld	can be welded with care	can be welded with care
Gas Metal Arc Welding (GMAW)	>3.0	Easy to weld	can be welded with care	can be welded with care
Submerged Arc Welding (SAW)	>6.0	can be welded with care	can be welded with care	can be welded with care
Resistance Spot welding	<3.0	Easy to weld	easy to weld	can be welded with care
Resistance Seam welding	<3.0	Easy to weld	can be welded with care	Difficult to weld Requires special care

Condensed ASTM specification for Stainless Steel Tubing and Piping

Specification	Allowable outside Diameter Variations in mm			Allowable Wall Thickness Variations		Exact Length Tolerances in mm		Testing
	Nominal Diameter	Over	Under	% Over	% Under	Over	Under	
ASTMA - 213 Seamless Boiler Superheater and Heat Exchanger Tubes	Under 25.4	.1016	.1016	+20	- 0	3.175	0	Tension Test Flattening Test Flare Test Hardness Test 100% Hydrostatic Test Refer to ASTMA - 450
	25.4 - 381 incl.	.1524	.1524	+20	- 0	3.175	0	
	38.1 - 50.8 excl.	.2032	.2032	+22	- 0	3.176	0	
	50.8 - 63.5 exc.	.254	.254	+22	- 0	4.76	0	
	63.5 - 76.2 Excl.	.3048	.3048	+22	- 0	4.76	0	
	76.2 - 101.6 incl.	.381	.381	+22	- 0	4.76	0	
ASTM A-249 Welder Boiler Superheater and Exchanger and Condenser Tubes	Under 25.4	.1016	.1016	+10	-10	3.175	0	Tension Test Flattering Test Flare Test Reverse Bend Test Hydrostatic Test 100% Hydrostatic Test Reverse Flattening Test Refer to ASTM A-450 wherever applicable
	25.4 - 381 incl.	.1524	.1524	+10	-10	3.175	0	
	38.1 - 50.8 excl.	.2032	.2032	+10	-10	3.175	0	
	50.8 - 63.5 excl.	.254	.254	+10	-10	4.76	0	
	63.5 - 76.2 exc.	.3048	.3048	+10	-10	4.76	0	
	76.2 - 101.6 incl.	.381	.381	+10	-10	4.76	0	
ASTM A-269 Seamless & Welded Tubing for General Service	Upto 12.7	.13	.13	+15	-15	3.2	0	Flare Test Flange Test (Welded only) Hardness Test Reverse Flattening Test (welded only) 100% Hydrostatic Test Refer to ASTM A-269
	12.7 - 38.1 excl.	.13	.13	+10	-10	3.2	0	
	38.1 - 88.9 excl.	.25	.25	+10	-10	4.8	0	
	88.9 - 139.7 excl.	.38	.38	+10	-10	4.8	0	
	139.7 - 203.2 excl.	.76	.76	+10	-10	4.8	0	
ASTM A-312 Seamless and Welded Austenitic Pipe	13.72 - 48.26	+0.40	-0.79	-12.5%				Tension Test Flattening Test 100% Hydrostatic Test
	60.33 - 114.3	+0.79	-0.79					
	141.3 - 219.08	+1.59	-0.79					
	168.28 - 219.08	+1.59	-0.79					
	273.05 - 373.85	+2.38	-0.79					
ASTM A-358 Welded Austenitic pipe	219.08 - 750 mm	± 0.5%		-0.3 mm				Refer to ASTM A-530
ASTM A-409 Welded austenitic pipe	355.6 - 750 mm	±0.2% to ±0.4%		-0.46 mm				Refer to ASTM A-530

ANSI B36.10 Stainless Steel Pipe Chart (weight Per Kg/mtr.)

Normal Size		Outside Diameter	Schedule 5		Schedule 10		Schedule 40		Schedule 80		Schedule 160		XX 80		XXS	
MM	INCH	MM	WT	WT KG/M	WT	WT KG/M	WT	WT KG/M	WT	WT KG/M	WT	WT KG/M	WT	WT KG/M	WT	WT KG/M
3	1/8	10.3	1.0	0.23	1.24	0.278	1.73	0.365	2.41	0.469	-	-	2.41	0.469	-	-
6	1/4	13.7	1.2	0.37	1.66	0.491	2.24	0.633	3.02	0.494	-	-	3.02	0.794	-	-
10	3/8	17.2	1.2	0.47	1.65	0.631	2.31	0.845	3.20	1.10	-	-	3.20	1.10	-	-
15	1/2	21.3	1.65	0.801	2.11	0.999	2.77	1.27	3.75	1.62	4.75	1.94	3.73	1.62	7.47	2.55
20	3/4	26.7	1.65	1.02	2.11	1.28	2.87	1.68	3.91	2.20	5.54	2.89	3.91	2.20	7.82	3.63
25	1	33.4	1.65	1.29	2.77	2.09	3.38	2.50	4.55	3.24	6.35	4.24	4.55	3.24	9.09	5.45
32	11/4	42.2	1.65	1.65	2.77	2.69	3.56	3.38	4.85	4.46	6.35	5.61	4.85	4.46	9.70	7.75
40	11/2	48.3	1.65	1.90	2.77	3.11	3.68	4.05	5.08	5.41	7.14	7.25	5.08	5.41	10.16	9.54
50	2	60.3	1.65	3.34	2.77	3.92	3.91	5.44	5.54	7.48	9.41	11.1	5.54	2.28	11.07	13.44
65	21/2	73.0	2.11	3.69	3.05	5.26	5.16	8.63	7.01	11.4	9.53	14.9	7.01	11.4	14.02	20.39
80	3	88.9	2.11	4.51	3.05	6.45	5.49	11.3	7.62	15.3	11.1	21.3	7.62	15.3	15.24	27.65
90	31/2	101.6	2.11	5.18	3.05	7.41	5.74	13.6	8.08	18.6	-	-	8.08	18.6	-	-
100	4	114.3	2.77	5.94	3.05	8.38	6.02	16.1	8.56	22.3	13.8	33.6	8.56	22.3	17.12	40.99
125	5	141.3	2.77	9.34	3.40	11.6	6.55	21.8	9.53	31.0	-	49.2	9.53	31.0	17.12	57.37
150	6	168.3	2.77	11.3	3.40	13.8	7.11	29.1	11.0	42.7	18.2	67.8	11.0	42.7	21.95	79.11
200	8	219.1	2.77	14.8	3.76	20.0	8.18	42.8	12.7	64.6	23.0	111.2	12.7	64.6	22.23	107.8
250	10	273.0	3.40	22.6	4.19	27.8	8.74	62.3	15.1	96.0	28.6	172.4	15.1	96.0	25.40	155.5
300	12	323.8	3.96	32.0	4.57	36.17	9.52	72.8	17.45	132.0	33.32	240.0	17.45	132.0	-	-
350	14	355.6	3.96	34.5	4.78	41.6	11.13	94.49	19.05	158.08	35.71	283.26	19.05	158.08	-	-
400	16	406.4	4.19	41.78	4.78	47.6	12.7	124.0	21.41	204.4	40.46	367.4	21.41	204.4	-	-
450	18	457.2	4.19	47.6	4.78	53.625	14.27	156.73.	23.8	255.77	45.71	466.4	23.8	255.77	-	-
500	20	508.0	4.78	59.65	5.54	69.0	15.6	184.06	26.19	312.9	49.99	567.75	26.19	312.9	-	-
600	24	609.6	5.54	82.98	6.35	94.98	17.45	256.22	30.34	435.9	54.52	811.85	30.34	435.8	-	-

Theoretical Mass

Weight of Round, Square & Hexagonal stainless steel Bars
Size in inches, Weight in kg /metre

Size(inch)	Round	Square	Hexagon	Size(inch)	Round	Square	Hexagon
1/16	0.0149	0.0196	-	2 7/8	33.2400	42.4142	36.7302
1/8	0.0631	0.0801	0.0754	3	36.2316	46.2036	39.9877
3/16	0.1419	0.1811	0.1509	3 1/4	42.5472	54.2144	45.8379
1/4	0.2519	0.3201	0.2715	3 1/2	49.3281	62.8568	54.4803
5/16	0.0466	0.5025	0.4377	3 3/4	56.5080	72.1640	62.5244
3/8	0.5657	0.7213	0.6189	4	64.4191	82.1028	71.3330
7/16	0.7711	0.9825	0.8452	4 1/4	72.8288	92.7063	78.8220
1/2	1.0065	1.2827	1.1165	4 1/2	81.6374	103.9414	90.0637
9/16	1.2754	1.6244	1.4037	4 3/4	90.9114	115.7749	101.2191
5/8	1.5725	2.0020	1.7357	5	100.7172	128.2731	111.1911
11/16	1.9049	2.4265	2.1127	5 1/4	111.0880	141.4362	122.5891
3/4	2.2669	2.8878	2.5046	5 1/2	121.8910	155.1310	134.5389
13/16	2.6605	3.39048	2.9277	5 3/4	133.2591	169.5904	147.0471
7/8	3.0843	3.9289	3.3971	6	144.9264	184.7479	160.1170
15/16	3.5400	4.5106	3.9090	6 1/4	157.3914	200.5701	173.6956
1	4.0220	5.1256	4.4375	6 1/2	170.1888	217.0239	187.8824
1 1/8	5.0923	6.4984	5.6275	6 3/4	183.6510	234.0627	202.6709
1 1/4	6.2956	8.0108	6.9405	7	197.4456	251.7265	217.9147
1 3/8	7.6119	9.7060	8.3631	7 1/4	211.7055	269.9752	233.7603
1 1/2	9.041	11.5342	10.0052	7 1/2	226.7300	288.8389	250.2141
1 5/8	10.6368	13.5453	11.7436	7 3/4	241.9207	308.4605	267.1166
1 3/4	12.3320	15.7225	13.6151	8	257.6100	328.6771	284.6175
1 7/8	14.1436	18.0327	15.6327	8 1/2	291.4217	371.0913	321.2878
2	16.1214	20.5090	17.7834	9	331.6022	416.0584	360.2218
2 1/8	18.1822	23.2347	20.0769	9 1/2	364.0245	463.4487	401.4228
2 1/4	20.4426	26.0535	22.4702	10	403.2012	513.5447	444.7312
2 3/8	23.2181	29.1847	25.0962	10 1/2	444.6847	566.2134	490.3066
2 1/2	25.1626	32.0766	27.7886	11	487.6308	621.4450	538.1456
2 5/8	27.7554	35.3341	30.6140	11 1/2	533.4189	679.2427	588.2482
2 3/4	30.4810	38.8243	33.5724	12	580.3704	739.4570	640.4616

Theoretical Mass

Weight (in kg/mtr) & Thickness of SS Pipe & Tube for Boiler, Heat Exchangers.

Size (inch)	O.D. (mm)	10G (3.25)	12G (2.64)	14G (2.03)	16G (1.62)	18G (1.21)	20G (0.91)	22G (0.71)
¼	6.35	0.025	0.232	0.216	0.192	0.152	0.122	0.099
5/16	7.93	0.378	0.349	0.295	0.262	0.199	0.159	0.126
3/8	9.52	0.505	0.448	0.442	0.322	2.659	0.192	0.152
½	12.70	0.751	0.664	0.521	0.445	0.349	0.262	0.209
¾	19.05	1.283	1.033	0.850	0.714	0.535	0.412	0.322
1	25.40	1.798	1.475	1.166	0.977	0.724	0.555	0.435
1 ¼	31.82	2.313	1.927	1.489	1.246	0.914	0.664	-
1 ½	38.10	2.828	2.326	1.801	1.502	1.103	-	-
1 ¾	44.45	3.390	2.765	2.147	1.761	1.296	-	-
2	50.80	3.859	3.191	2.436	2.017	1.485	-	-
2 ¼	57.15	4.371	3.606	2.752	2.283	1.675	-	-
2 ½	63.50	4.892	4.022	3.071	2.632	1.868	-	-
2 ¾	69.85	5.418	4.447	3.311	2.815	2.057	-	-
3	76.20	5.923	4.853	3.706	3.071	2.247	-	-
3 ½	88.90	6.953	5.710	4.341	3.596	2.629	-	-
4	101.60	7.987	6.551	4.976	4.118	3.008	-	-
4 ½	114.30	9.018	7.392	5.344	4.643	3.390	-	-
5	127.00	10.048	8.233	6.245	5.165	3.769	-	-
5 ½	139.70	11.168	9.074	6.880	5.694	4155	-	-
6	152.40	12.145	9.915	7.515	6.232	4.533	-	-
6 ½	165.10	13.212	10.822	8.150	6.741	4.902	-	-

DOs and DON'Ts

The general terminology, prevention is better than cure is applicable not only to human beings but also to Stainless Steel. Stainless Steel has to be handled carefully and must be kept clean to increase its service life. The following precautions should be taken while using stainless steel. The following points may be positively taken care of :-

1. Keep SS with original packing or wrapping till the start of fabrication.
2. Keep material indoors, in racks or wooded shelves and for enhanced performance keep the items covered.
3. It is advisable to keep SS far away from carbon steel. Fine particles may scale from carbon steel fabrication or fragments of other metals may come in contact with SS and lead to local rust spots.
4. Avoid walking on SS with dirty shoes or dirty industrial boots.
5. Use clean glove or clean cloth while handling SS.
6. Remove residues of other material from fabricating equipment before taking up SS fabrication.
7. Use paper or other protective coverings to protect SS surface during storage and fabrication.
8. Tools like cutting shears, hold down pads, abrasive cut off wheels, equipment for roll forming, bending, drawing etc should either be used exclusively for SS or should be wiped to make them free from adherent mild steel particles or oil, grease etc. Do not use the same grinding wheels for SS and carbon steel.
9. Sources of carbon contamination like oil, grease, varnish, paint, wax, marking pen and other foreign material should not be brought in contact with SS.
10. Do not allow chemicals or bleaching agents to remain in prolonged contact with stainless steel.
11. Edges of thermally cut SS should be cleaned by machining or grinding to remove surface contamination.
12. Weldments with heat tints should also be cleaned either mechanically or chemically or electrochemically.
13. Clean grinding wheels should be used to remove the weld spatter.
14. After cleaning and grinding, weldments should be passivated and smoothened.

Gauge Measures and their equivalent in millimeter

Gauge No.	Thickness in mm		
	SWG	BG	AWG / BS
1	7.620	7.971	7.348
2	7.010	7.993	6.543
3	6.401	7.122	5.830
4	5.893	6.350	5.190
5	5.385	5.652	43620
6	4.877	5.032	4.110
7	4.470	4.481	3.670
8	4.064	3.988	3.260
9	3.658	3.551	2.910
10	3.251	3.175	2.590
11	2.946	2.827	2.300
12	2.642	2.517	2.050
13	2.337	2.240	1.830
14	2.032	1.994	1.630
15	1.829	1.775	1.450
16	1.626	1.588	1.290
17	1.422	1.412	1.150
18	1.219	1.257	1.020
19	1.016	1.118	0.910
20	0.914	0.996	0.810

Gauge No.	Thickness in mm		
	SWG	BG	AWG / BS
21	0.813	0.886	0.720
22	0.711	0.794	0.640
23	0.610	0.707	0.573
24	0.559	0.629	0.511
25	0.508	0.560	0.455
26	0.457	0.498	0.405
27	0.417	0.443	0.361
28	0.376	0.397	0.321
29	0.345	0.353	0.286
30	0.315	0.312	0.255
31	0.295	0.279	0.227
32	0.274	0.249	0.202
33	0.254	0.221	0.180
34	0.234	0.196	0.160
35	0.213	0.175	0.143
36	0.193	0.155	0.127
37	0.173	0.137	0.113
38	0.152	0.122	0.101
39	0.132	0.109	0.090
40	0.122	0.098	0.080

SWG - Standard Wire Gauge
BG - Birmingham Gauge
AWG / BS - American Brown and Sharpe's Gauge

Stainless Steel Flanges

Types and Application

A flange is a forged or cast ring of steel designed to connect section of pipe or join pipe to a pressure vessel, valve, pump or any other integral flanged assembly.

Flanges are joined to each other by bolting and joined to the piping system by welding or threading.

The basic types of flanges are : **Slip On, Blind, Weldneck, Threaded, Socket Weld, Lap Joint and Plate.**

Flanges are designed to the following pressure rating : 150 lb, 300 lb, 400 lb, 600 lb, 900 lb, 1500 lb and 2500 lb or 10 Bar, 15 Bar, 25 Bar, 40 Bar, 64 Bar, 100 Bar and 150 Bar.

The most common facings machined on flanges are : (a) Raised face (b) Flat face (c) Ring type

Slip on Flanges

The Flange is slipped over the pipe and then welded both inside and outside to provide sufficient strength and prevent leakage. This flange is used in preference to weld necks by many users because of its lower cost and the fact that less accuracy is required while cutting pipe to length.

Blind Flanges

This is flange without a bore and it is used to shut off a piping system or vessel opening. It also permits easy access to vessel or piping system for inspection purpose. Blind flanges can be supplied with or without hubs at the manufacturer's option.

Weld neck flanges

This is designed to be joined to a piping system by butt welding. It is relatively expensive because of its long neck, but is preferred for high stresses to the pipe, reducing stress applications. The neck, or hub, transmits stress concentration at the base of the flange. The gradual transition of thickness from the base of the hub to the wall thickness at the butt weld provides important reinforcement of the flange. The bore of the flange matches the bore of the pipe, reducing turbulence and erosion.

Threaded Flanges

This is similar to a slip on flange in outline but bore is threaded, thus enabling assembly without welding. This obviously limits its application to relatively low pressure piping systems. The flange may be welded around the joint after method of increasing its applications.

Socket weld flanges

This is similar to a slip-on flanges in outline, but the bore is counter-bored to accept pipe. The diameter of the remaining bore is the same as the inside diameter of the pipe. The flange is attached to the pipe by a fillet weld around the hub of the flange. An optional interval weld may be applied in high stress applications. Its biggest use is in high pressure systems such as hydraulic and steam line.

Lap joint flanges

This is again similar to a slip-on flange, but it has radius at the intersection of the bore and the flange face to accommodate a lap stub end. The face on the stub end forms the gasket face of the flange. The type of the flange is used in application where sections of piping systems need to be dismantled quickly and easily for inspection or replacement.

Plate Flange

This is usually used with a pressed collar or stub end and is placed behind the collar or stub end. It is not weld and thus allows for easy alignment. Also permits use of other materials for the flange isnot in direct contact with the liquid.

Table D - BS-10 Flange

Flange designation nominal bore of pipe	Approx. Outside diameter of Steel Pipe H	Diameter of flange D	Pitch Circle diameter (PCD) P	No. of Bolts N	Diameter of bolts O	Thickness T
in	in	in	in	in	in	in
½	27/32	3 ¾	2 5/8	4	½	3/16
¾	1 1/16	4	2 7/8	4	½	3/16
1	1 11/32	4 ½	3 ¼	4	½	3/16
1 ¼	1 11/16	4 ¾	3 7/16	4	½	¼
1 ½	1 29/32	5 ¼	3 7/8	4	½	¼
2	2 3/8	6	4 ½	4	5/8	5/16
2 ½	3	6 ½	5	4	5/8	5/16
3	3 ½	7 ¼	5 ¾	4	5/8	3/8
4	4 ½	8 ½	7	4	5/8	3/8
5	5 ½	10	8 ¼	8	5/8	½
6	6 5/8	11	9 ¼	8	5/8	½
8	8 5/8	13 ¼	11 ½	8	5/8	½
10	10 ¾	16	14	8	¾	5/8
12	12 ¾	18	16	12	¾	¾
14	14	20 ¾	18 ½	12	7/8	7/8
16	16	22 ¾	20 ½	12	7/8	7/8
18	18	25 ¼	23	12	7/8	1
20	20	27 ¾	25 ¼	16	7/8	1 1/8
22	22	30	27 ½	16	1	1 1/8
24	24	32 ½	29 ¾	16	1	1 ¼

Table E - BS-10 Flange

Flange designation nominal bore of pipe	Approx. Outside diameter of Steel Pipe H	Diameter of flange D	Pitch Circle diameter (PCD) P	No. of Bolts N	Diameter of bolts O	Thickness T
in	in	in	in	in	in	in
½	27/32	3 ¾	2 5/8	4	½	¼
¾	1 1/16	4	2 7/8	4	½	¼
1	1 11/32	4 ½	3 ¼	4	½	9/32
1 ¼	1 11/16	4 ¾	3 7/16	4	½	5/16
1 ½	1 29/32	5 ¼	3 7/8	4	½	11/32
2	2 3/8	6	4 ½	4	5/8	3/8
2 ½	3	6 ½	5	4	5/8	13/32
3	3 ½	7 ¼	5 ¾	4	5/8	7/16
4	4 ½	8 ½	7	4	5/8	½
5	5 ½	10	8 ¼	8	5/8	9/16
6	6 5/8	11	9 ¼	8	¾	11/16
8	8 5/8	13 ¼	11 ½	8	¾	¾
10	10 ¾	16	14	12	7/8	7/8
12	12 ¾	18	16	12	7/8	1
14	14	20 ¾	18 ½	12	7/8	1 1/8
16	16	22 ¾	20 ½	12	7/8	1 ¼
18	18	25 ¼	23	16	7/8	1 3/8
20	20	27 ¾	25 ¼	16	7/8	1 ½
22	22	30	27 ½	16	1	1 ¾
24	24	32 ½	29 ¾	16	1 1/16	1 7/8

Table F - BS-10 Flange

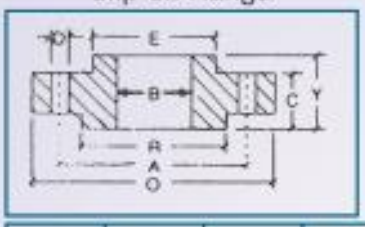
½	27/32	3 ¾	2 5/8	4	½	3/8
¾	1 1/16	4	2 7/8	4	½	3/8
1	1 11/32	4 ¾	3 7/16	4	5/8	3/8
1 ¼	1 11/16	5 ¼	3 7/8	4	5/8	½
1 ½	1 29/32	5 ½	4 1/8	4	5/8	½
2	2 3/8	6 ½	5	4	5/8	5/8
2 ½	3	7 ¼	5 ¾	8	5/8	5/8
3	3 ½	8	6 ½	8	5/8	5/8
4	4 ½	9	7 ½	8	5/8	¾
5	5 ½	11	9 ¼	8	¾	7/8
6	6 5/8	12	10 ¼	12	¾	7/8
8	8 5/8	14 ½	12 ¾	12	¾	1
10	10 ¾	17	15	12	7/8	11/8
12	12 ¾	19 ¼	17 ¼	16	1	1 ¼
14	14	21 ¾	19 ½	16	1	1 3/8
16	16	24	21 ¼	20	1	1 5/8
18	18	26 ½	24	20	1 1/8	1 ¾
20	20	29	26 ½	24	1 1/8	2
22	22	31	28 ½	24	1 1/8	2 1/8
24	24	33 ½	30 ¾	24	1 ¼	2 ¼

Table H - BS-10 Flange

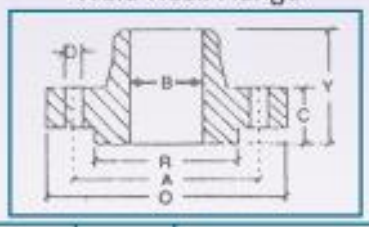
½	27/32	4 ½	3 ¼	4	5/8	½
¾	1 1/18	4 ½	3 ¾	4	5/8	½
1	1 11/32	4 ¾	3 7/18	4	5/8	8/16
1 ¼	1 11/16	5 ¼	3 7/8	4	5/8	9/16
1 ½	1 29/32	5 ½	4 1/8	4	5/8	¾
2	2 3/8	6 ½	5	4	5/8	11/16
2 ½	3	7 ¼	5 ¾	8	5/8	¾
3	3 ½	8	6 ½	8	5/8	7/8
4	4 ½	9	7 ½	8	5/8	1
5	5 ½	11	9 ¼	8	¾	1 1/8
6	6 5/8	12	10 ¼	12	¾	1 1/8
8	8 5/8	14 ½	12 ¾	12	¾	1 1/4
10	10 ¾	17	15	12	7/8	1 3/8
12	12 ¾	19 ¼	17 ¼	16	7/8	1 5/8
14	14	21 ¾	19 ½	16	1	1 7/8
16	16	24	21 ¼	20	1	2 1/8
18	18	26 ½	24	20	1 1/8	2 3/8
20	20	29	26 ½	24	1 1/8	2 5/8
22	22	31	28 ½	24	1 1/8	2 3/4
24	24	33 ½	30 ¾	24	1 ¼	3

Dimensions of class 150 Flanges as per ANSI B 16.5

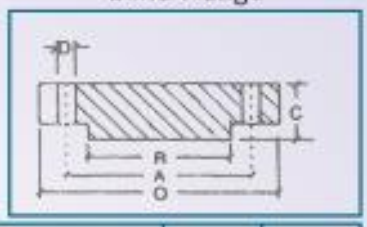
Slip-on Flange



Weld Neck Flange



Blind Flange



Nominal Pipe Size	Flange Dia O	Dia of Bolt Grade A	Dia of Bolt Holes D	No. of Holes	Thk of Flange C	Dia of Sub E	Length through Hub			Dia of bore		Dia of R/F R	Depth of Socket F
							S/O & S/W Y	W/N Y	L/J Y	S/O & S/W B	L/J B		
15	88.9	60.3	15.9	4	11.1	30.2	15.9	47.6	15.9	22.3	22.9	34.9	9.5
20	98.4	69.8	15.9	4	12.7	38.1	15.9	52.4	15.9	27.7	28.2	42.9	11.1
25	107.9	79.4	15.9	4	14.3	49.2	17.5	55.6	17.5	34.5	35.0	50.8	12.7
32	117.5	88.9	15.9	4	15.9	58.7	20.6	57.1	20.6	43.2	43.7	63.5	14.3
40	127.0	98.4	15.9	4	17.5	65.1	22.2	61.9	22.2	49.5	50.0	73.0	15.9
50	152.4	120.6	19.0	4	19.0	77.8	25.4	63.5	25.4	62.0	62.5	92.1	17.5
65	177.8	139.7	19.0	4	22.2	90.5	28.6	69.8	28.6	74.7	75.4	104.8	19.0
80	190.5	152.4	19.0	4	23.8	107.9	30.2	69.8	30.2	90.7	91.4	127.0	20.6
100	228.6	190.5	19.0	8	23.8	134.9	33.3	76.2	33.3	116.1	116.8	157.2	23.8
125	254.0	215.9	22.2	8	23.8	163.5	36.5	88.9	36.5	143.8	144.5	185.7	23.8
150	279.4	241.3	22.2	8	25.4	192.1	39.7	88.9	39.7	170.7	171.4	215.9	27.0
200	342.9	298.4	22.2	8	28.6	246.1	44.4	101.6	44.4	221.5	222.2	269.9	31.7
250	406.4	361.9	25.4	12	30.2	304.8	49.2	101.6	49.2	276.3	277.4	323.8	33.3
300	482.6	431.8	25.4	12	31.8	365.1	55.6	114.3	55.6	327.1	328.2	381.0	39.7
350	533.4	476.2	28.6	12	34.9	400.0	57.1	127.0	79.4	359.1	360.2	412.7	41.3
400	596.9	539.7	28.6	16	36.5	457.2	63.5	127.0	87.3	410.5	411.2	469.9	44.4
450	635.0	577.8	31.7	16	39.7	504.8	68.3	139.7	96.8	461.8	462.3	533.4	49.2
500	698.5	635.0	31.7	20	42.9	558.8	73.0	144.5	103.2	513.1	514.3	584.2	54.0
600	812.8	749.3	34.9	20	47.6	663.6	82.5	152.4	111.1	615.9	615.9	692.1	63.5

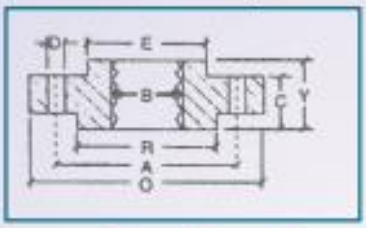
Dimensions of class 300 Flanges as per ANSI B 16.5

15	95.2	66.7	15.9	4	14.3	38.1	22.2	52.4	22.2	22.3	22.9	34.9	9.5
20	117.5	82.5	19.0	4	15.9	47.6	25.4	57.1	25.4	27.7	28.2	42.9	11.1
25	123.8	88.9	19.0	4	17.5	54.0	27.0	61.9	27.0	34.5	35.0	50.8	12.7
32	133.3	98.4	19.0	4	19.0	63.5	27.0	65.1	27.0	43.2	43.7	63.5	14.3
40	155.6	114.3	22.2	4	20.6	69.8	30.2	68.3	30.2	49.5	50.0	73.0	15.9
50	165.1	127.0	19.0	8	22.2	84.1	33.3	69.8	33.3	62.0	62.5	92.1	17.5
65	190.5	149.2	22.2	8	25.4	100.0	38.1	76.2	38.1	74.7	75.4	104.8	19.0
80	209.5	168.3	22.2	8	28.6	117.5	42.9	79.4	42.9	90.7	91.4	127.0	20.6
100	254.0	200.0	22.2	8	31.8	146.0	47.6	85.7	47.6	116.1	116.8	157.2	23.8
125	279.4	234.9	22.2	8	34.9	177.8	50.8	98.4	50.8	143.8	144.5	185.7	-
150	317.5	269.9	22.2	12	36.5	206.4	52.4	98.4	52.4	170.7	171.4	215.9	-
200	381.0	330.2	25.4	12	41.3	260.3	61.9	111.1	61.9	221.5	222.2	269.9	-
250	444.5	387.3	28.6	16	47.6	320.7	66.7	117.5	95.2	276.3	277.4	323.8	-
300	520.7	450.8	31.7	16	50.8	374.6	73.0	130.2	101.6	327.1	328.2	381.0	-
350	584.2	514.3	31.7	20	54.0	425.4	76.2	142.9	111.1	359.1	360.2	412.7	-
400	647.7	571.5	34.9	20	57.2	482.6	82.5	146.0	120.6	410.5	411.2	469.9	-
450	711.2	628.5	34.9	24	60.3	533.4	88.9	158.7	130.2	461.8	462.3	533.4	-
500	774.7	685.8	34.9	24	63.5	587.4	95.2	161.9	139.7	513.1	514.3	584.2	-
600	914.4	812.8	41.3	24	69.8	701.7	106.4	168.3	152.4	615.9	615.9	692.1	-

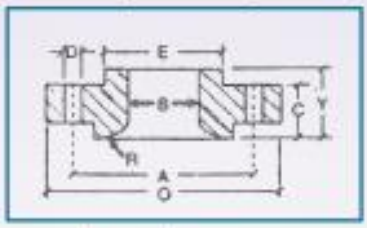
Dimensions of class 600 Flanges as per ANSI B 16.5

All dimensions are in millimeters

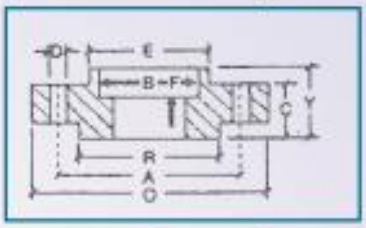
Threaded Flange



Lap Joint Flange



Socket-weld Flange



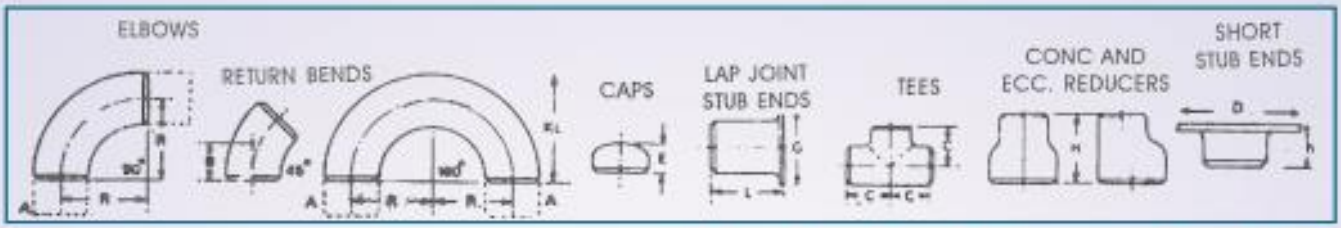
Nominal Pipe Size	Flange Dia O	Dia of Bolt Grade A	Dia of Bolt Holes D	No. of Holes	Thk of Flange C	Dia of Sub E	Length through Hub S/O & S/W Y	Length through Hub W/N Y	Length through Hub L/J Y	Dia of bore S/O & S/W B	Dia of bore L/J B	Dia of R/F R	Depth of Socket F
15	95.2	66.7	15.9	4	14.3	38.1	22.2	52.4	22.3	22.3	22.8	34.9	9.5
20	117.5	82.5	19.0	4	15.9	47.6	25.4	57.1	25.4	27.7	28.1	42.9	11.1
25	123.8	88.9	19.0	4	17.5	54.0	27.0	61.9	26.9	34.5	35.0	50.8	12.7
32	133.3	98.4	19.0	4	20.6	63.5	28.6	66.7	28.4	43.2	43.6	63.5	14.2
40	155.6	114.3	22.2	4	22.2	69.8	31.7	69.8	31.7	49.5	50.0	73.0	15.8
50	165.1	127.0	19.0	8	25.4	84.1	36.5	73.0	36.5	62.0	62.4	92.1	17.4
65	190.5	149.2	22.2	8	28.6	100.0	41.3	79.4	41.1	74.7	75.4	104.8	19.0
80	209.5	168.3	22.2	8	31.8	117.5	46.0	82.5	45.9	90.7	91.4	127.0	-
100	273.0	215.9	25.4	8	38.1	152.4	54.0	101.6	53.8	116.1	116.8	157.2	-
125	330.2	266.7	28.6	8	44.4	188.9	60.3	114.3	60.4	143.8	141.5	185.7	-
150	355.6	292.1	28.6	12	47.6	222.2	66.7	117.5	66.5	170.7	171.4	215.9	-
200	419.1	349.2	31.7	12	55.6	273.0	76.2	133.3	76.2	221.5	222.2	269.9	-
250	508.0	431.8	34.9	16	63.5	342.9	85.7	152.4	111.2	276.3	277.3	323.8	-
300	558.8	488.9	34.9	20	66.7	400.0	92.1	155.6	117.3	327.1	328.1	381.0	-
350	603.2	527.0	38.1	20	69.9	431.8	93.7	165.1	127.0	359.1	360.1	412.7	-
400	685.8	603.2	41.3	20	76.2	495.3	106.4	177.8	139.7	410.5	411.2	469.9	-
450	742.9	654.0	44.4	20	82.6	546.1	117.5	184.1	152.4	461.8	462.2	533.4	-
500	812.8	723.9	44.4	24	88.9	609.6	127.0	190.5	165.1	513.1	514.3	584.2	-
600	939.8	838.2	50.8	24	101.6	717.5	139.7	203.2	184.1	615.9	615.9	692.1	-

Dimensions of class 900 Flanges as per ANSI B 16.5

All dimensions are in millimeters

15	120.6	82.5	22.2	4	22.2	38.1	31.7	60.3	31.7	22.2	22.8	34.9	9.5
20	130.2	88.9	22.2	4	25.4	44.4	34.9	69.8	35.0	27.7	28.1	42.9	11.1
25	149.2	101.6	25.4	4	28.6	52.4	41.3	73.0	41.1	34.5	35.0	50.8	12.7
32	158.7	111.1	25.4	4	28.6	63.5	41.3	73.0	41.1	43.2	43.6	63.5	14.2
40	177.8	123.8	28.6	4	31.8	69.8	44.4	82.5	44.4	49.5	50.0	73.0	15.8
50	215.9	165.1	25.4	8	38.1	104.8	57.1	101.6	57.1	62.0	62.4	92.1	17.4
65	244.5	190.5	28.6	8	41.3	123.8	63.5	104.8	63.5	74.7	75.4	104.8	19.0
80	241.3	190.5	25.4	8	38.1	127.0	53.9	101.6	53.8	90.7	91.4	127.0	-
100	292.1	234.9	31.7	8	44.4	158.7	69.8	114.3	69.8	116.0	116.8	157.1	-
125	349.2	279.4	35.0	8	50.8	190.5	79.3	127.0	79.2	143.7	114.5	185.7	-
150	381.0	317.5	31.7	12	55.6	234.9	85.8	139.7	85.8	170.6	171.4	215.9	-
200	469.9	393.7	38.1	12	63.5	298.4	101.6	162.0	114.3	221.4	222.2	269.8	-
250	546.1	469.9	38.1	16	69.8	368.3	107.9	184.1	127.0	276.3	277.3	323.8	-
300	609.6	533.4	38.1	20	79.3	419.1	117.4	200.0	142.7	327.1	328.1	381.0	-

Dimensions in mm of Butt Welding fittings to ANSI B16.9



Nom Bore	Pipe O.D	Wall Thickness				Radius R				A	B	C	E	G	L		H	D	H
		5S	10S	40S	80S	1D	1.5D	2D	3D						Short	Long			
½	21.34	1.65	2.11	2.77	3.73	12.7	19.05	25.4	38.1	12.7	15.9	25.4	25.4	34.9	50.8	76.2	50.8	45	8
¾	26.67	1.65	2.11	2.87	3.91	19.05	28.57	38.10	57.15	19.05	11.1	28.6	25.4	42.8	50.8	76.2	50.8	50	8
1	33.40	1.65	2.77	3.38	4.55	25.4	38.1	50.8	76.2	25.4	22.2	38.1	38.1	50.8	50.8	101.6	50.8	60	10
1¼	42.16	1.65	2.77	3.56	4.85	31.75	47.6	63.5	95.25	31.75	25.0	47.6	38.1	63.5	50.8	101.6	50.8	70	12
1 ½	48.26	1.65	2.77	3.68	5.08	38.1	57.15	76.2	114.3	38.10	28.6	57.2	38.1	73.0	50.8	101.6	63.5	80	12
2	60.32	1.65	2.77	3.91	5.54	50.8	76.2	101.6	152.4	50.8	34.0	63.5	38.1	92.0	63.5	152.4	76.2	94	16
2½	73.02	2.11	3.05	5.16	7.01	63.5	95.25	127.0	190.5	63.5	44.0	76.2	38.1	104.8	63.5	152.4	88.9	110	16
3	88.90	2.11	3.05	5.49	7.62	76.2	114.30	152.4	228.6	76.2	50.8	85.7	50.8	127.0	63.5	152.4	88.9	130	18
3½	101.60	2.11	3.05	5.74	8.08	88.9	133.35	177.8	266.7	88.9	57.2	95.3	63.5	139.7	76.2	152.4	101.6	140	18
4	114.30	2.11	3.05	6.02	8.56	101.6	152.4	203.2	304.8	101.6	63.5	104.8	63.5	157.2	76.2	152.4	101.6	158	20
5	141.30	2.77	3.40	6.55	9.52	127.0	190.5	254.0	381.0	127.0	82.6	123.8	76.2	185.7	76.2	203.2	127.0	188	25
6	168.27	2.77	3.40	7.11	10.97	152.4	228.6	304.8	457.2	152.4	95.3	158.7	88.9	215.9	88.9	203.2	139.7	212	25
8	219.07	2.77	3.76	8.18	12.7	203.2	304.8	406.4	609.6	203.2	127.0	190.5	101.6	270.0	101.6	203.2	152.4	268	30
10	273.05	3.40	4.19	9.27	12.7	254.0	381.0	508.0	762.0	254.0	158.7	215.9	127.0	324.0	127.0	254.0	177.8	330	35
12	323.85	3.96	4.57	9.52	12.7	304.8	457.2	609.6	914.4	304.8	190.5	254.0	152.4	381.0	152.4	254.0	203.2	400	40
14	355.60	3.96	4.76	9.52	12.7	355.6	533.4	711.12	1066.8	355.6	222.2	280.0	165.1	412.8	152.4	305.0	330.2	-	-
16	406.40	4.19	4.76	9.52	12.7	406.4	609.6	812.8	1219.2	406.4	254.0	304.8	177.8	470.0	152.4	305.0	355.6	-	-
18	457.20	4.19	4.76	9.52	12.7	457.2	685.8	914.4	1371.6	457.2	285.7	343.0	203.2	533.4	152.4	305.0	381.0	-	-
20	508.00	4.76	5.54	9.52	12.7	508.0	762.0	101.6	1524.0	508.0	317.6	381.0	228.6	584.2	152.4	305.0	508.0	-	-

Standards : All dimensions are in mm and cofirm to ANSI B 16.9 and MSSP sp 43 where applicable - Dimensional tolerances are in accordance with ANSI B 16.9 dh M.S.S. SP-43 where applicable.

Radius : Radius of short radius elbows is 1 times nominal pipe diameter, Radius of Long radius elbows is 1½ time nominal pipe diameter.

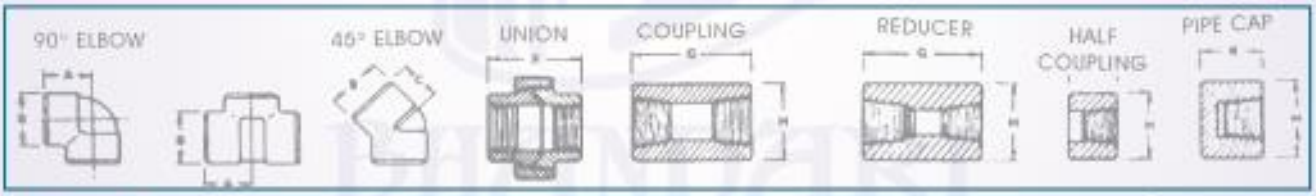
Material of Construction : S.S. 304/304L/316L/321 Nickel 200 & Nickel Alloys.
MS Carbon Steel and Alloy Steel also.

Dimensions in mm of Socket Weld fittings to ANSI B16.11

Nom Bore	Pipe O.D	2000 LBS / 3000 LBS																
		A	B	C	D		E	F	G	K	L	M	N	O	P	Q		
⅛	13.7	20.6	22.2	14.1	9.5		11.1	19.0	8.0	25.4	36.5	22.2	31.7	6.4	17.5	9.5		
3/8	17.2	24.6	25.4	17.5	11.1		13.5	19.0	8.0	28.6	36.5	25.4	36.5	6.4	19.0	9.5		
½	21.3	28.6	33.3	21.7	12.7		15.8	22.2	11.1	35.0	38.1	31.7	43.0	9.5	22.2	9.5		
¾	26.7	33.4	38.1	27.0	14.3		19.0	25.4	12.7	38.1	46.0	38.1	51.0	9.5	25.4	12.7		
1	33.4	38.1	46.0	33.8	15.8		22.2	28.6	14.3	44.4	52.3	44.5	60.3	12.7	27.0	12.7		
1¼	42.2	44.4	55.5	42.5	17.4		27.0	33.3	17.4	47.8	54.0	57.2	70.0	12.7	30.2	12.7		
1½	48.3	50.8	62.0	48.6	19.0		31.7	35.0	20.6	50.8	55.5	63.5	82.5	12.7	31.8	12.7		
2	60.3	60.3	75.4	61.1	22.2		38.1	42.8	25.4	63.5	68.2	76.2	95.2	19.0	38.1	15.9		

Standard : Pipe Fittings & Flanges • ANSI B 16.9 (VS) 1640 • ANSI B-16, 11 (BS) 3799 • ANSI B-16.5 (BS) 1560
• Compression (Tube type Fitting) • Dairy (I.D.F. SM) I Breweries & Distilleries

Dimensions in mm of screwed fittings to ANSI B16.11 thread to ASA B2.1



Nom Bore	Pipe O.D	3000 LBS									6000 LBS								
		A	B	C	F	G	H	J	K		A	B	C	F	G	H	j	K	
1/8	10.3	20.6	22.2	19.0	40.0	31.7	19.0	15.9	19.0		24.6	25.4	19.0	40.0	31.7	22.2	15.9	25.4	
¼	13.7	24.6	25.4	19.0	43.0	35.0	19.0	17.5	25.4		28.6	33.3	22.2	43.0	34.9	25.4	17.5	33.3	
3/8	17.2	28.6	33.3	22.2	47.6	38.1	22.2	19.0	25.4		33.3	38.1	25.4	47.6	38.1	31.7	19.0	38.1	
½	21.3	33.3	38.1	25.4	51.0	47.6	28.6	23.8	31.7		38.1	46.0	28.6	51.0	47.6	38.1	23.8	46.0	
¾	26.7	38.1	46.0	28.6	57.1	50.8	35.0	25.4	36.5		44.4	55.5	33.3	57.1	50.8	44.5	25.4	55.6	
1	33.4	44.4	55.5	33.3	63.5	60.3	44.5	30.2	41.3		50.8	62.0	35.0	63.5	60.3	57.2	30.2	61.9	
1¼	42.2	50.8	62.0	35.0	73.0	66.7	57.2	33.3	44.5		60.3	75.4	42.8	73.0	66.7	63.5	33.3	75.4	
1½	48.3	60.3	75.4	42.8	80.0	79.4	63.5	39.7	44.5		63.5	84.1	43.6	80.0	79.4	76.2	39.7	84.1	
2	60.3	63.5	84.1	43.6	89.0	85.7	76.2	42.9	47.6		82.5	101.6	52.4	89.0	85.7	92.2	42.9	101.6	

Ordering Information

While placing order, please mention the following specifications so that we can supply products that fully satisfy your needs as regards price, delivery and product quality.

1. Applicable Standard (e.g. ASTM, DIN, IS etc)
2. Grade (e.g. 202, 304, 316, 310, 321, 420 etc.)
3. Surface finish (e.g. 2B, 2A, BA, No.1, No.4, No.8 etc.)
4. Dimension (e.g. Thickness, width, length in mm / inches / meter etc.)
5. Quantity (e.g. weight in kg, length in meter, no.of pieces etc.)
6. Tolerance limits
7. Application (e.g. Deep Drawing, Heat exchange etc.)
8. Delivery schedule
9. Special Requirements (e.g. Plastic coated, specific packing etc.)

Note :- There is no minimum order.

Enquiry & order can be sent by courier, e-mail at below details :

BHANDARI

BHANDARI METAL SYNDICATE

202/4, Linghi Chetty Street , Broadway
Chennai - 600 001.
Phone: 2346 3751, 4235 8151
Email: bhandari_bms@yahoo.com

BHANDARI METAL INDUSTRIES

5, Singanna naicken Street, Broadway
Chennai - 600 001.
Phone: 044 - 4235 8161, 2346 3752,
Email: bhandari_bmi@yahoo.in

www.bhandarimetals.in

For More Details: 98403 26979 / 95005 77777 / 93833 87888

For any technical assistance/clarification, mail to: bhandari_bms@yahoo.com, bhandari_bmi@yahoo.in

Note: The formulae and calculations detailed in the handbook are purely for providing infomation only

We are thankful to our clients for the faith, co-operation, understanding and atmost good wishes received in years and years to come. We take this oppurtunity to serve you with enthusiasm, greater vigour and dedication to maintain the smile.

Formulae of Calculating Weight

Weight of Stainless Steel Pipe
O.D. (MM) - W.Thick (mm) x W.Thick (mm) x 0.0248 = Wt. per Mtr.
O.D. (mm) - W.Thick (mm) x W.Thick (mm) x 0.00756 = Wt. per Feet.

Weight of Stainless Steel Round Bar
Dia (mm) x Dia (mm) x 0.00623 = Wt. per Mtr.
Dia (mm) x Dia (mm) x 0.0019 = Wt. per Feet

Weight of Stainless Steel Square Bar
Dia (mm) x Dia (mm) x 0.00788 = Wt. per Mtr.
Dia (mm) x Dia (mm) x 0.0024 = Wt. per Feet

Weight of Stainless Steel hexagonal Bar
A/F (mm) x A/F (mm) x 0.00680 = Wt. per Mtr.
A/F (mm) x A/F (mm) x 0.002072 = Wt. per Feet

Weight of Stainless Steel Flat Bar
Width (mm) x Thickness (mm) x 0.00798 = Wt. per Mtr.
Width (mm) x Thickness (mm) x 0.00243 = Wt. per Feet

Weight of Stainless Steel Sheets & Plates
Length (Mtrs) x Width (Mtrs) x Thick (mm) x 8 = Wt. per PC
Length (Feet) x Width (Feet) x Thick (mm) x 3/4 = Wt. per PC

Weight of Stainless Steel Circle
Dia (mm) x Dia (mm) x Thick (mm) 160 = Gms. per PC
Dia (mm) x Dia (mm) x Thick (mm) x 0.0000063 = Kg per PC

Weight of Brass Metal
Weight of Stainless Steel + 9%

Weight of Copper Metal
Weight of Stainless Steel + 12%

Weight of Aluminium Metal
Weight of Stainless Steel ÷ 3

Conversion
1 Metre = 3.2808 Foot
1 Foot = 304.8 mm
1 Inch = 25.4 mm

Barlow's Formula for calculating bursting pressure
P = 2ST/D or t-DP/2S or S-DP/2T or D=2ST/P
P = Bursting Pressure Psi
S = Tensile Strenght of tube
T = Wall thickness (in inches)
D - Outside Diameter (in inches)

* Formula for Healthy Business
Honesty+Quality Goods+Quick Service+Reasonable Rate = Good Healthy Business

BHANDARI

BHANDARI METAL SYNDICATE

202/4, Linghi Chetty Street , Broadway
Chennai - 600 001.
Phone: 2346 3751, 4235 8151
Email: bhandari_bms@yahoo.com

BHANDARI METAL INDUSTRIES

5, Singanna naicken Street, Broadway
Chennai - 600 001.
Phone: 044 - 4235 8161, 2346 3752,
Email: bhandari_bmi@yahoo.in

www.bhandarimetals.in

For More Details: 98403 26979 / 95005 77777 / 93833 87888

THE POWER OF RESISTANCE