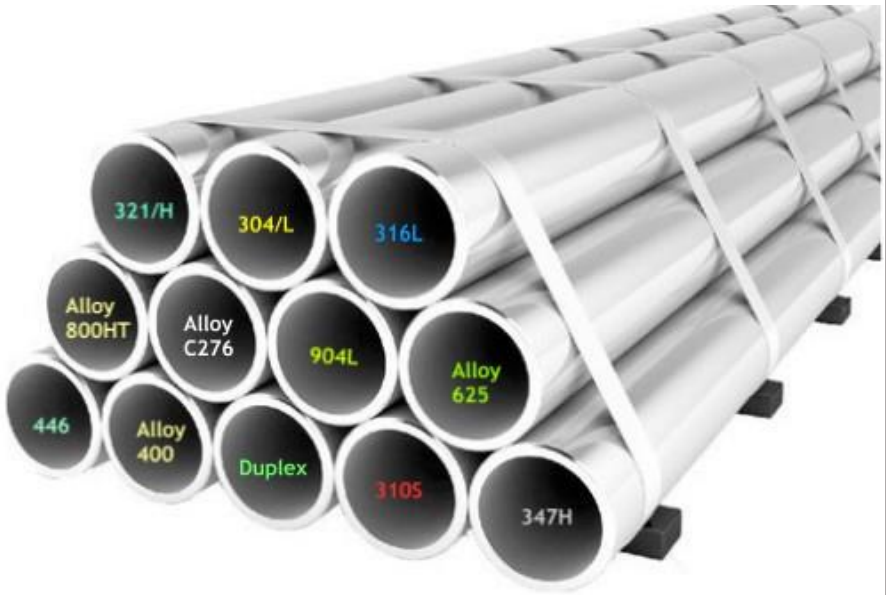
A335 P11, P12, P22, P91 ALLOY STEEL

Datasheet for A335 P11, P12, P22, P91 Alloy Steel

- Pipes & Tubes
- Sheets & Plates
- Bars & Rods, Forgings
- Fittings & Flanges
- Nuts & Bolts
- Valves



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Datasheet for Alloy Steel A335 P11, P12, P22, P91

What is Alloy Steel A335?

ASTM A335 / A335M - Standard Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service.

This specification covers seamless ferritic alloy-steel pipe for high-temperature service. The pipe shall be suitable for bending, flanging (vanstoning), and similar forming operations, and for fusion welding. Grade P2 and P12 steel pipes shall be made by coarse-grain melting practice. The steel material shall conform to chemical composition, tensile property, and hardness requirements. Each length of pipe shall be subjected to the hydrostatic test. Also, each pipe shall be examined by a non-destructive examination method in accordance to the required practices. The range of pipe sizes that may be examined by each method shall be subjected to the limitations in the scope of the respective practices. The different mechanical test requirements for pipes, namely, transverse or longitudinal tension test, flattening test, and hardness or bend test are presented.

- Ferritic steels in this specification are defined as low- and intermediate-alloy steels containing up to and including 10 % chromium.
- Main Steel Pipe Grades - P2, P5, P9, P11, P12, P22, P23, P91, P92

Alloy Steel A335 P11, P12, P22, P91 Product Specification

Product	ASTM A335 P11, P12, P22, P91 Seamless Alloy Tubes
Specification	ASTM A335/A335M, ASME SA335
Type	Seamless
Size	50.8 to 860 mm
Thickness	2.77 to 100mm
Length	Single Random Length, Double Random Length, or as customer’s requirement.
Grades	P1, P2, P5, P9, P11, P12, P22, P91
Test Certificates	Material Test Certificates (MTC) as per EN 10204 3.1 and EN 10204 3.2

Chemical Composition of ASTM A335 P11, P12, P22, P91 Alloy Steel Seamless Tubes - Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service

Chemical Components (%)												
Grade	C	Mn	P	S	Si	Cr	Mo	V	Nb	N	Al	Others
P11	0.05-0.15	0.30-0.60	≤0.025	≤0.025	0.50-1.00	1.0-1.50	0.44-0.65	-	-	-	-	-
P12	0.05-0.15	0.30-0.61	≤0.025	≤0.025	≤0.50	0.80-1.25	0.45-0.65	-	-	-	-	-
P22	0.05-0.15	0.30-0.60	≤0.025	≤0.025	≤0.50	1.90-2.60	0.87-1.13	-	-	-	-	-
P91	0.08-0.12	0.30-0.60	≤0.020	≤0.010	0.20-0.50	8.0-9.50	0.85-1.05	0.18-0.25	0.030-0.070	≤0.40	≤0.02	Cb 0.06-0.10 Ti 0.01max Zr 0.01max

Mechanical Properties of ASTM A335 P11, P12, P22, P91 Alloy Steel Seamless Tubes - Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service

Grade	Tensile Strength (Mpa)	Yield Strength (Mpa)	Elongation (%)	Hardness (HRB)
P11	≥415	≥220	≥30	≤89
P12	≥415	≥220	≥30	≤89
P22	≥415	≥200	≥30	≤89

P91	≥585	≥415	≥20	≤91HRB-25HRC

Heat Treatment Requirements for ASTM A335 P11, P12, P22, P91 Alloy Steel Seamless Tubes - Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service

Grade	UNS Number	Heat Treat Type	Austenitizing / Solutioning Temperature, min or range °F [°C]	Subcritical Annealing or Tempering Temperature, Min or range °F [°C]
P11	K11597	full or isothermal anneal normalize and temper	-	1200 [650] [650 to 730]
P12	K11562	full or isothermal anneal normalize and temper subcritical anneal	-	1200 [650] 1200-1300 [650 to 705]
P22	K21590	full or isothermal anneal normalize and temper	-	1250 [675]
P91	K91560	normalize and temper quench and temper	1900-1975[1040-1080] 1900-1975[1040-1080]	1350-1470[730-800] 1350-1470[730-800]

Tests & Inspection of Alloy Steel Pipes - Gr. P11, P22 & P91 Pipes

- Chemical Composition Analysis Test With 100% PMI and One tube from each heat by Direct Reading Spectrometer
- Visual Test and Endoscope Test for Surface Quality Test
- 100% Hydro static Test and 100% Eddy Current Test
- Ultrasonic Test subject to the MPS (Material Purchase Specification)
- Mechanical Tests includes Tension Test, Flattening Test, Flaring Test, Hardness Test
- Impact Test subject to Standard request
- Grain Size Test and Inter granular Corrosion Test
- Ultrasonic measuring of Wall Thickness

- 100% Eddy current test after corrugation.
- Visual test and dimensional inspection after corrugation.

Ordering Information for Alloy Steel Pipes, as per ASTM A335

- Orders for material under this specification should include the following, as required, to describe the desired material adequately:
- Quantity (feet, centimetres, or number of lengths),
- Name of material (seamless alloy steel pipe),
- Grade
- Manufacture (hot-finished or cold-drawn),
- Size (NPS or outside diameter and schedule number or average wall thickness),
- Length (specific or random),
- End finish (Ends Section of Specification A999/A 999M),
- Test report required (Certification Section of Specifi- cation AA 999/A 999M),
- Specification designation,
- Special requirements or any supplementary requirements selected, or both.

Materials and Manufacture

- Pipe may be either hot finished or cold drawn with the finishing treatment
- Grade P2 and P12 - The steel shall be made by coarse- grain melting practice. Specific limits, if any, on grain size or deoxidation practice shall be a matter of agreement between the manufacturer and purchaser.

Heat Treatment of Alloy Steel Pipes

- All pipe of grades except P5c, P91, P92, and P122 as provided, shall be reheated and furnished in the full-annealed, isothermal annealed, or normalized and tempered condition. If furnished in the normalized and tempered condition, the minimum tempering temperature for Grades P5, P5b, P9, P21, and P22 shall be 1250°F [675°C], the minimum tempering temperature for Grades P1, P2, P11, P12, and P 15 shall be 1200°F [650°C].
- It is recommended that the temperature for tempering should be at least 100°F [50°C] above the intended service temperature; consequently, the purchaser should advise the manufacturer if the service temperature is to be over 1100°F [600°C].
- Pipe of Grades P1, P2, and P12, either hot finished or cold drawn, may be given a final heat treatment at 1200°F [650°C] to 1300°F [705°C] instead of heat treatments
- All pipe of Grades P5c shall be given a final heat treatment in the range from 1325°F [715°C] to 1375°F [745°C].

- Certain of the ferritic steels covered by this specification will harden if cooled rapidly from above their critical temperature. Some will air harden, that is, become hardened to an undesirable degree when cooled in air from high temperatures. Therefore, operations involving heating such steels above their critical temperatures, such as welding, flanging, and hot bending, should be followed by suitable heat treatment.
- Grade T92 shall be normalized at 1900°F [1040°C] minimum and tempered at 1350°F [730°C] minimum as a final heat treatment.
- Grade P122 shall be normalized at 1900°F [1040°C] minimum, and tempered at 1350°F [730°C] minimum as a final heat treatment.
- Except when Supplementary Requirement S7 is speci- fied by the purchaser, Grade P91 shall be normalized at 1900°F [1040°C] minimum, and tempered at 1350°F [730°C] mini- mum as a final heat treatment. Alternatively, liquid quenching and tempering is allowed for thicknesses above 3 in. when mutually agreed upon between the manufacturer and the purchaser. In this case the pipe shall be quenched from 1900°F [1040°C] minimum and tempered at 1350°F [730°C] minimum as final heat treatment.

ASTM A335 Chemical Composition

Grade	ASTM A335 Chemical Composition									
	C	Mn	P max	S max	Si	Cr	Mo	V	N	Others
P1	0.1-0.2	0.3-0.8	0.025	0.025	0.1-0.5	1.0-1.5	0.44-0.65	/	/	/
P2	0.1-0.2	0.3-0.61	0.025	0.025	0.1-0.3	0.5-0.81	0.44-0.65	/	/	/
P5	≤0.15	0.3-0.6	0.025	0.025	≤0.5	4.0-6.0	0.45-0.65	/	/	/
P5b	≤0.15	0.3-0.6	0.025	0.025	1.0-2.0	4.0-6.0	0.45-0.65	/	/	/
P5c	≤0.12	0.3-0.6	0.025	0.025	≤0.5	4.0-6.0	0.45-0.65	/	/	/
P9	≤0.15	0.3-0.6	0.025	0.025	0.25-1.0	8.0-10.0	0.9-1.1	/	/	/
P11	0.05-0.15	0.3-0.6	0.025	0.025	0.5-1.0	1.0-1.5	0.44-0.65	/	/	/
P12	0.05-0.15	0.3-0.61	0.025	0.025	≤0.5	0.8-1.25	0.44-0.65	/	/	/
P15	0.05-0.15	0.3-0.6	0.025	0.025	1.15-1.65	/	0.44-0.65	/	/	/
P21	0.05-0.15	0.3-0.6	0.025	0.025	≤0.5	2.65-3.35	0.8-1.06	/	/	/

P22	0.05-0.15	0.3-0.6	0.025	0.025	≤0.5	1.9-2.6	0.87-1.13	/	/	/
P23	0.04-0.1	0.1-0.6	0.03	0.01	≤0.5	1.9-2.6	0.05-0.3	0.2-0.3	≤0.015	Cb(0.02-0.08) ,B(0.001-0.006) Al(≤0.03), W(1.45-1.75) Ni(≤0.4), Ti(0.005-0.060)
P24	0.05-0.1	0.3-0.7	0.02	0.01	0.15-0.45	2.2-2.6	0.9-1.1	0.2-0.3	≤0.012	Ti(0.06-0.1), Al(≤0.02) B(0.0015-0.007)
P36	0.1-0.17	0.8-1.2	0.03	0.025	0.25-0.50	≤0.30	0.25-0.50	≤0.02	≤0.02	Ni(1.0-1.3), Cu(0.5-0.8) Cb(0.015-0.045), Al(≤0.050)
P91	0.08-0.12	0.3-0.6	0.02	0.01	0.2-0.5	8.0-9.5	0.85-1.05	0.18-0.25	0.03-0.07	Ni(≤0.4), Al(≤0.02), Cb(0.06-0.1) Ti(≤0.01), Zr(≤0.01)
P92	0.07-0.13	0.3-0.6	0.02	0.01	≤0.50	8.5-9.5	0.3-0.6	0.15-0.25	0.03-0.07	Ni(≤0.4), AL(≤0.02), Cb(0.04-0.09) W(1.5-2.0), B(0.001-0.006) Ti(≤0.01), Zr(≤0.01)
P122	0.07-0.14	≤0.7	0.02	0.01	≤0.50	10.0-11.5	0.25-0.6	0.15-0.3	0.04-0.1	Ni(≤0.5), Al(≤0.02), Ti(≤0.01) W(1.5-2.5), Cu(0.3-1.7), Zr(≤0.01) Cb(0.04-0.1), B(0.0005-0.005)
P911	0.09-0.13	0.3-0.6	0.02	0.01	0.1-0.5	8.5-9.5	0.9-1.1	0.18-0.25	0.04-0.09	Ni(≤0.4), Cb(0.06-0.1) B(0.0003-0.006),Al(≤0.02)

										W(0.9-1.1),Ti(≤0.01),Zr(≤0.01)

- New designation established in accordance with Practice E 527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).
- Grade P5c shall have a titanium content of not less than 4 times the carbon content and not more than 0.70 %; or a columbium content of 8 to 10 times the carbon content.

Mechanical Properties for ASTM A335 Pipes

ASTM A335 Mechanical Properties			
Grade	Tensile Strength(MPa)	Yield Strength(MPa)	Elongation(%)
A335 P1	≥415	≥205	≥30
A335 P2	≥380	≥205	≥30
A335 P5	≥415	≥205	≥30
A335 P9	≥415	≥205	≥30
A335 P11	≥415	≥205	≥30
A335 P12	≥415	≥205	≥30
A335 P15	≥415	≥205	≥30
A335 P21	≥415	≥205	≥30
A335 P22	≥415	≥205	≥30
A335 P23	≥585	≥415	≥20
A335 P24	≥585	≥415	≥20
A335 P36	≥585	≥415	≥20

A335 P91	≥585	≥415	≥20
A335 P92	≥620	≥440	≥20
A335 P122	≥620	≥440	≥20
A335 P911	≥620	≥440	≥20

Size Tolerances for ASTM A335

Outside Diameter Tolerance

ASTM A450	Hot rolled	Outside Diameter(mm)	Tolerance(mm)
		OD≤101.6	+0.4/-0.8
		101.6＜OD≤190.5	+0.4/-1.2
		190.5＜OD≤228.6	+0.4/-1.6
	Cold Drawn	OD＜25.4	±0.10
		25.4≤OD≤38.1	±0.15
		38.1＜OD＜50.8	±0.20
		50.8≤OD＜63.5	±0.25
		63.5≤OD＜76.2	±0.30
		76.2≤OD≤101.6	±0.38
		101.6＜OD≤190.5	+0.38/-0.64
		190.5＜OD≤228.6	+0.38/-1.14

ASTM A530, ASTM A335	NPS	Outside Diameter(inch)	Tolerance(mm)
		1/8≤OD≤1-1/2	±0.40
		1-1/2＜OD≤4	±0.79
		4＜OD≤8	+1.59 / -0.79
		8＜OD≤12	+2.38 / -0.79
		12＜OD	±1%

Thickness Tolerance for ASTM A335 Pipes

ASTM A450	Hot rolled	Outside Diameter(mm)	Tolerance (%)
		OD≤101.6,WT≤2.4	+40 / -0
		OD≤101.6,2.4＜WT≤3.8	+35 / -0
		OD≤101.6,3.8＜WT≤4.6	+33 / -0
		OD≤101.6,4.6＜WT	+28 / -0
		101.6＜OD,2.4＜WT≤3.8	+35 / -0
		101.6＜OD,3.8＜WT≤4.6	+33 / -0
		101.6＜OD,4.6＜WT	+28 / -0
	Cold Drawn	OD≤38.1	+20 / -0
		OD＞38.1	+22 / -0

ASTM A530	NPS	Outside Diameter(inch)	Tolerance (%)
		1/8≤OD≤2-1/2	+22 / -12.5
		3≤OD≤18,WT/OD≤5%	+22.5 / -12.5
		3≤OD≤18,WT/OD＞5%	+15 / -12.5
		20≤OD,WT/OD≤5%	+22.5 / -12.5
		20≤OD,WT/OD＞5%	+15 / -12.5

Hydrostatic Test

- Each length of pipe shall be subjected to the hydro-static test,
- Unless otherwise specified in the purchase order, each length of pipe shall, at the option of the manufacturer, be subjected to the nondestructive electric test in lieu of the hydrostatic test.
- When specified by the purchaser, pipe shall be fur- nished without hydrostatic test and without nondestructive examination.
- When specified by the purchaser, pipe shall be fur- nished with both the hydrostatic test and a nondestructive examination having been performed.

Mechanical Tests Required

- Transverse or Longitudinal Tension Test and Flattening Test, Hardness Test, or Bend Test—For material heat treated in a batch-type furnace, tests shall be made on 5% of the pipe from each treated lot. For small lots, at least 1 pipe shall be tested. For material heat treated by the continuous process, tests shall be made on a sufficient number of pipe to constitute 5 % of the lot, but in no case less than 2 pipe.
- The term “lot” applies to all pipe of the same nominal size and wall thickness (or schedule) which is produced from the same heat of steel and subjected to the same finishing treatment in a continuous furnace; when final heat treatment is in a batch-type furnace, the lot shall include only that pipe which is heat treated in the same furnace charge.

Hardness Test

- For pipe of Grade P122, Brinell, Vickers, or Rock- well hardness tests shall be made on a specimen from each lot.

Bend Test

- For pipe whose diameter exceeds NPS 25 and whose diameter to wall thickness ratio is 7.0 or less shall be subjected to the bend test instead of the flattening test. Other pipe whose diameter equals or exceeds NPS 10 may be given the bend test in place of the flattening test subject to the approval of the purchaser.
- The bend test specimens shall be bent at room temperature through 180° without cracking on the outside of the bent portion. The inside diameter of the bend shall be 1 in. [25 mm].
- Test specimens for the bend test shall be cut from one end of the pipe and, unless otherwise specified, shall be taken in a transverse direction. One test specimen shall be taken as close to the outer surface as possible and another from as close to the inner surface as possible. The specimens shall be either 1⁄2 by 1⁄2 in. [12.5 by 12.5 mm] in section or 1 by 1⁄2 in. [25 by 12.5 mm] in section with the corners rounded to a radius not over 1⁄16 in. [1.6 mm] and need not exceed 6 in. [150 mm] in length. The side of the samples placed in tension during the bend shall be the side closest to the inner and outer surface of the pipe, respectively.

Applications of Alloy Steel

- Alloy steel seamless pipes are widely used for low and medium pressure fluid transportation pipeline, casing tube, boiler pipe, petroleum and natural gas industry, chemistry industry, power generation industry, transformers, agriculture, bearings, general engineering, automotive, hydraulics, railway, mining, construction, aerospace, medical, defense and electric motors.
- Alloy steels grade P91 is mainly used for power industry. For welded construction, the ASME Boiler and Pressure Vessel Code limits the carbon content to less than 0.35%.
- Alloy steel is ideally suited for applications that require higher strength, improved toughness or better wear resistance than standard carbon steel grades.
- Alloy Steels are used in boiler construction because they are inexpensive, readily available, easily formed and welded to the desired shape and, within the broad limits, are oxidation- and corrosion-resistant enough to provide satisfactory service for many years to many industries.
- Alloy Steel is used across a range of highly demanding applications within the aerospace and power (nuclear) industries.
- Alloy Steel is also found in applications where its response to magnetism is important, in transformers and electric motors for example.

Properties of Alloy Steel

- It is the addition of other elements that makes alloy steel extra strong. The elements such as silicon and manganese through heat treatment makes alloy steel with improved characteristics and additional benefits, such as increased corrosion resistance or improved weldability.
- The mechanical properties achievable are dependent on the addition of elements such as nickel, chromium, molybdenum and vanadium. The following is a range of improved properties in alloy steels (as compared to carbon steels): strength, hardness, toughness, wear resistance, corrosion resistance, hardenability, and hot hardness.
- To achieve some of these improved properties the metal may require heat treating. HSLA stands for high-strength low-alloy steel.

Types of Alloy Steel

There are 2 major types of alloy steel.

1. High-Alloy Steel**: -**

High-alloy steels are defined by a high percentage of alloying elements. The most common high-alloy steel is stainless steel, which contains at least 12 percent chromium. Stainless steel is generally split into three basic types: martensitic, ferritic, and austenitic. Martensitic steels contain the least amount of chromium, have a high hardenability, and are typically used for cutlery. Ferritic steels contain 12 to 27 percent chromium and are often used in automobiles and industrial equipment. Austenitic steels contain high levels of nickel, carbon, manganese, or nitrogen and are often used to store corrosive liquids and mining, chemical, or pharmacy equipment.

2. Low-Alloy Steel

Low-alloy steels have a much lower percentage of alloying elements, usually 1 to 5 percent. These steels have very different strengths and uses depending on the chosen alloy. Large diameter flanges manufacturers typically choose alloys for a specific mechanical property. The variety of potential alloys makes low-alloy steel useful for a variety of projects, including seamless rolled ring forging and studding outlet manufacturing.

While there are a lot of different alloying elements that can be used to improve the mechanical properties of steel, certain combinations are used often and there are different types of alloy steel that are more popular than others.

High strength low alloy (HSLA) steel is an alloy that provides greater atmospheric corrosion resistance and high strength. There are six different classifications of HSLA steel, with varying alloying elements used. Typically, vanadium, niobium, titanium, and copper are used to provide the increased strength, and copper, chromium, phosphorus, and silicon are used to increase corrosion resistance. Due to the high strength of HSLA steels, they can often be harder to form, in some cases calcium or zirconium are added to improve formability. Chrome moly is another common alloy steel. This material is an alloy of chromium and molybdenum, which improves hardenability, increase strength, high temperature resistance, corrosion, and oxidation resistance.

ALLOY	SPECIFICATION	MAXIMUM USEFUL TEMPERATURE
Carbon-steel	SA178, SA192,	850°
	SA210, SA106,	
	SA515, SA516	
Carbon-1/2 Molybdenum	SA209	900°
1 1/4 Chromium-	SA213 T-11	1025°

1/2 Molybdenum	SA335 P-11	
2 1/4 Chromium-	SA213 T-22	1075°
1 Molybdenum	SA335 P-22	
18 Chromium-	SA213 TP304(H),	1500°
10 Nickel	321(H), 347(H)	

Principle Effects of Major Alloying Elements On Alloy Steel

Element	Percentage	Primary function
Aluminium	0.95–1.30	Alloying element in nitriding steels
Bismuth	-	Improves machinability
Boron	0.001–0.003	A powerful hardenability agent
Chromium	0.5–2	Increases hardenability
	4–18	Increases corrosion resistance
Copper	0.1–0.4	Corrosion resistance
Lead	-	Improved machinability
Manganese	0.25–0.40	Combines with sulphur and with phosphorus to reduce the brittleness. Also helps to remove excess oxygen from molten steel.
	>1	Increases hardenability by lowering transformation points and causing transformations to be sluggish

Molybdenum	0.2–5	Stable carbides; inhibits grain growth. Increases the toughness of steel, thus making molybdenum a very valuable alloy metal for making the cutting parts of machine tools and also the turbine blades of turbojet engines. Also used in rocket motors.
Nickel	2–5	Toughener
	12–20	Increases corrosion resistance
Silicon	0.2–0.7	Increases strength
	2	Spring steels
	Higher percentages	Improves magnetic properties
Sulphur	0.08–0.15	Free-machining properties
Titanium	-	Fixes carbon in inert particles; reduces martensitic hardness in chromium steels
Tungsten	-	Also increases the melting point.
Vanadium	0.15	Stable carbides; increases strength while retaining ductility; promotes fine grain structure. Increases the toughness at high temperatures

Standards & Codes Specification

Commonly Used Standards and Codes

Sr. No	Code	Standards
1	ANSI B16.11	Pipe Flanges and Flanged Fittings.

2	ANSI B 16.5	Flanges
3	MSS SP-44	Large Dia Flanges.
4	ASME B 16.47 (SERIES A & B)	Large Dia Flanges.
5	DIN	Flanges
6	BS 4504	Flanges
7	ASTM A105	Forging, Carbon Steel for piping components
8	ASTM A182	Forged & Rolled Alloy Steel Pipe Flanges. Forged Fittings & Valves and parts for high temperature services.
9	ASTM A 350	Carbon & Low Alloy Steel, requiring notch toughness testing for piping components
10	ASTM A 515	Standard specifications for Pressure Vessel-Plates Carbon Steel for intermediate and higher temperature services.
11	ASTM A 516	Standard Specifications for Pressure Vessel Plates Carbon steel for Moderate and lower temperature services.
12	ASTM A 517	Standard specifications for Pressure Vessel Plates Alloy Steel High Strength Quenched & Tempered.
13	ASTM A 333	Standard specification for Seamless & Welded Steel Pipe for Low Temperature Services.
14	ASTM A 335	Standard Specification for Seamless Ferritic Alloy steels pipe for High Temperature Services.
15	IS 2002	Specification for steels Plates for Boilers.
16	IS 2062	Specification for weldable structure steel.
17	IS 1239	Mild Steel Tubes Tubular & other wrought steel fittings specification.
18	IS 3589	Mild Steel Tubes Tubular & other wrought steel fittings specification.

Comparison of Properties of Various Steel at Room Temperature

The table below shows the typical properties of steels at room temperature (25°C). The wide ranges of tensile strength, yield strength, and hardness are largely due to different heat treatment conditions.

Properties	Carbon Steels	Alloy Steels	Stainless Steels	Tool Steels
Density (1000 kg/m3)	7.85	7.85	7.75-8.1	7.72-8.0
Elastic Modulus (GPa)	190-210	190-210	190-210	190-210
Poisson's Ratio	0.27-0.3	0.27-0.3	0.27-0.3	0.27-0.3
Thermal Expansion (10-6/K)	11-16.6	9.0-15	9.0-20.7	9.4-15.1
Melting Point (°C)			1371-1454	
Thermal Conductivity (W/m-K)	24.3-65.2	26-48.6	11.2-36.7	19.9-48.3
Specific Heat (J/kg-K)	450-2081	452-1499	420-500	
Electrical Resistivity (10-9W-m)	130-1250	210-1251	75.7-1020	
Tensile Strength (MPa)	276-1882	758-1882	515-827	640-2000
Yield Strength (MPa)	186-758	366-1793	207-552	380-440
Percent Elongation (%)	10-32	4-31	12-40	5-25
Hardness (Brinell 3000kg)	86-388	149-627	137-595	210-620

[Image Source: From Web]

Manufacturing Alloy Steel Pipes & Tubes in ASTM A209 T1, T1a, T1b

Alloy Steel Pipes	Alloy Steel Seamless Pipes

Alloy Steel Welded Pipes	Alloy Steel High Temperature Pipes
Alloy Steel Flanges	Alloy Steel Buttweld Fittings
Alloy Steel Forged Fittings	Alloy Steel Socket Weld Pipe Fittings
Alloy Threaded Fittings	Alloy Steel High Pressure Pipes
Alloy Steel Nuts & Bolts	Alloy Steel U Bends & Tubes
Alloy Steel Forgings	Alloy Steel Tubes
Alloy Steel Boiler Tubes	Alloy Steel Seamless Tubing
Alloy Steel Heat Exchanger Tubes	Alloy Steel Large Diameter Pipes

About Metallica Metals – The Steel Pipes Factory

- Established in 1975, the Metallica Metals Group (The Steel Pipes Factory) has its operations spread across major cities in India. We are a pioneer in the stainless steel pipes, nickel alloy products, titanium products, carbon steel pipes and alloy steel pipes manufacturing and processing industry. Our products including pipe fittings, flanges, pipes, sheet plates and valves are exported to over 70 countries across the world, while in India we have supplied to even the remote areas. With over 250 tons of sale in stainless steel and carbon steel pipes every day, Metallica has emerged as a prominent vendor for many buyers in India and Overseas
- More than 3000 tons ready from stock and new production ready in just a few weeks.
- Feel free to contact us on - Email: info@metallicametals.com | Tel: +91 8928722715 | +91-22-66581538, +91-22-67436694, +91-22-66109768

Our Key Products

STAINLESS STEEL & NICKEL ALLOYS	INSTRUMENTATION TUBES & FITTINGS	PRODUCTS
Pure Nickel Alloys	Instrumentation Tube	Steel Sheet & Plate
Monel Alloys (Ni-Cu Alloys)	Hydraulic Tubing	Steel Coil & Strip
Inconel (Ni-Cr-Mo) Alloys	Seamless Tubing	Steel Pipes
Incoloy Alloys (Ni-Cr-Fe)	Instrumentation Tube Fittings	Steel Tubes
Hastelloy Alloys	Double Compression Tube Fittings	Electropolish Tube

Stainless Steel 304/304L
Stainless Steel 309S/309H
Stainless Steel 310/310S
Stainless Steel 316/316L
Stainless Steel 316Ti
Stainless Steel 317/317L
Stainless Steel 321/321H
Stainless Steel 347/347H
Stainless Steel 904L
Duplex Steels (UNS S32205, UNS S31803)
Super Duplex Steels (UNS S32760 / UNS S32750)
Stainless Steel 254 SMO (UNS S31254 / 1.4547)

Precision Pipe Fittings
Needle & Guage Valves
Manifold Valves

Heat Exchanger Tubes
Steel Bars/Rods & Wire
Fasteners (Nut, Bolt, Washer)
Steel Angle Bars
Hex Steel Bars
Round Steel Bars & Rod
Flat Steel Bars
Forgings, Rings & Forged Blocks
Stainless Steel Pipe
Stainless Steel Seamless Pipe
Stainless Steel Welded Pipe
Stainless Steel Tubes
Stainless Steel Furnace Tubes
Stainless Steel Seamless Tubing
Stainless Steel Heat Exchanger Tubes
Large Diameter Pipe

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