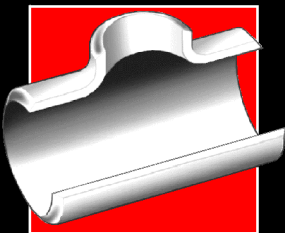


# Section 1

## Materials

This Section contains information to aid the understanding of stainless steel materials, their properties and applications, and to give guidance in the selection of grades.



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## Introduction

Stainless steel is the name given to a group of corrosion-resistant steels containing a minimum of 11% chromium together with varying additions of nickel, molybdenum, titanium, niobium and other elements. The mechanical properties and behaviour in service of each type of steel depends upon its composition. Consequently a considered choice of the steel is vital. A check list below may prompt aspects that you need to consider in making that choice.

There are four main types of stainless steel used in the production of tubular products, namely Austenitic, Ferritic, Duplex, and Martensitic. The basic compositions and properties of these steels are considered in the following subsections.

Within the four main types of stainless steel, individual materials are assigned grade or type designations depending on their exact chemical compositions. This manual primarily refers to the most common American AISI grades and the UNS (Unified Numbering System) designations as defined in various ASTM standards. International equivalent (and near equivalent) grades are listed at the end of the section.

Tables correlating individual stainless steel grades to ASTM standards and detailing their chemical compositions are also included in this section, and in the subsequent sections which cover ASTM pipe, tube and fitting standards in more detail.

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### Material Selection Check List

The following general points should be considered when defining the grade of stainless steel required for a particular application.

- Corrosion resistance required.
- Resistance to oxidation.
- Resistance to sulphidation.
- Stability of properties when in service.
- Deterioration of properties at service temperatures.
- Strength at ambient and service temperatures.
- Ductility at ambient and service temperatures.
- Suitability for in service cleaning techniques.
- Effect of expansion in service.
- Suitability for intended fabrication techniques.
- Weldability.
- Toughness of the material.
- Resistance to abrasion and erosion.
- Surface finish and/or appearance.
- Magnetic properties.
- Electrical resistivity.

# Types of Stainless Steel

This subsection considers the four main types of stainless steel, comparing their chemical compositions, characteristics and properties in general terms. Example grades are also described as an introduction to the way in which the alloys have been developed and improved for different functions.

## Austenitic Stainless Steels

This is the most common and extensive class of stainless steel, sometimes referred to as 18-8, i.e. 18% chromium - 8% nickel, although the actual composition may vary widely from these figures. Their properties may be summarised as follows:

- **Corrosion resistance** - Austenitics are among the most highly corrosion-resistant materials available. They can however be susceptible to stress corrosion cracking.
  - **Ductility** - Austenitics are ductile and can be formed easily. This applies at both high and low temperatures.
  - **Tensile Strength** - Austenitics have high tensile and yield strengths. Susceptibility to stress corrosion cracking means that high tensile stresses in service should be minimised.
  - **Hardness** - Austenitics cannot be hardened by heat treatment but they do strain harden rapidly when cold worked. Heat treatment is used to provide stress relief after cold working.
  - **Weldability** - Good, assuming manufacturers recommendations are followed. Austenitics are less problematic than ferritic and martensitic stainless steels in this respect.
  - **Magnetism** - Austenitics are non-magnetic. Cold working may increase magnetic permeability.
  - **Thermal expansion** - Austenitics have a thermal expansion approximately 50% higher than that of carbon steel.
- Rapid cooling (e.g. quenching in water) from the annealing temperatures prevents this, but may cause distortion of thin wall products. This problem is addressed by the stabilised grades and low carbon alloys.
- **Stabilised austenitic grades** (e.g. AISI 321, 347, 348) - These alloys contain controlled amounts of titanium or niobium to render the steel nearly immune to chromium carbide precipitation and its adverse effect on corrosion resistance. Annealing is still used for stress relief, to increase softness and ductility, and for additional stabilisation, but rapid cooling is not required to prevent intergranular corrosion.
  - **Low-carbon austenitic grades** (e.g. AISI 304L, 316L, 317L) - The low carbon content of these alloys limits the precipitation of intergranular carbides compared with conventional austenitics. This limited sensitisation is of value for welding and hot working operations. However, low carbon alloys are not suitable for prolonged service at sensitising temperatures (approximately 540 to 760 °C) at which carbides may be formed.
  - **Other grades** contain varying levels of alloying elements (e.g. AISI 304N, 304LN, 309Cb), the effects of which are summarised on page 1-5, or may be modified for particular requirements such as high temperature service (e.g. AISI 304H, 310HCb). Super austenitics (e.g. UNS S31050, S31254) have up to 7% molybdenum, matching contents of chromium and nickel, and may also be alloyed with nitrogen. These are most often designed to resist pitting and crevice corrosion in chloride containing environments such as sea water.

## Example Austenitic Grades

Subdivisions of austenitic stainless steels include:

- **Conventional austenitic grades** (e.g. AISI 301, 302, 303, 304, 305, 308, 310, 316, 317) - These are usually furnished in an annealed or cold worked state. Following welding or thermal processing, further annealing may be required to optimise corrosion resistance, softness and ductility. Chromium carbides, which markedly reduce resistance to intergranular corrosion, are dissolved during annealing, but may be precipitated during the cooling.

# Types of Stainless Steel

## Duplex Stainless Steel

Duplex stainless steels have a mixed microstructure of austenite and ferrite, and hence combine the optimum properties of austenitic and ferritic steels. Their properties may be summarised as follows:

- **Corrosion resistance** - Duplex alloys have the high corrosion resistance properties of austenitics plus good resistance to chloride stress corrosion cracking.
  - **Ductility** - Duplex steels are similar to austenitics in this respect, except that higher initial force is required to plasticise the material.
  - **Tensile Strength** - Duplex alloys typically have a higher tensile strength and twice the yield strength compared with conventional austenitics. This can result in a reduction in the required wall thickness and weight of the tubular products.
  - **Hardness** - Duplex alloys are more impact resistant than ferritics. Embrittlement can occur with prolonged use at temperatures above 300 °C.
- Work hardening is similar to austenitics but heat treatment to provide stress relief is not normally required due to its resistance to stress corrosion cracking.
- **Weldability** - Good assuming manufacturers recommendations are followed.
  - **Thermal expansion** - Duplex alloys have a thermal expansion nearer that of carbon steel than is the case with austenitics.

### Example Duplex Grades

Example duplex grades are UNS S31803, S32304 and S32750. Duplex grades with a PRE (Pitting Resistance Equivalent = %Cr + 3.3%Mo + 16% N) number greater than 40 are known as **super duplex** (e.g. UNS S32750).

## Ferritic Stainless Steel

Ferritic stainless steels contain chromium in the range 11 - 18%. Their properties may be summarised as follows:

- **Corrosion resistance** - Ferritics have moderate corrosion-resistance but are particularly resistant to stress corrosion cracking.
  - **Ductility** - Ferritics are readily formed, behaving in a similar manner to carbon steel but with slightly lower formability.
  - **Tensile Strength** - Ferritics have similar tensile and yield strengths to austenitics.
  - **Hardness** - Ferritics cannot be hardened by heat treatment. Annealing is used to develop minimum hardness and maximum ductility, toughness and corrosion resistance. Embrittlement can occur during cooling.
- **Weldability** - Care is needed during welding.
  - **Magnetism** - Ferritics are magnetic.

### Example Ferritic Grades

Subdivisions of ferritic stainless steels include conventional ferritic grades (e.g. AISI 405, 409, 430) and low-interstitial ferritics (e.g. UNS S44700 and S44800).

## Martensitic Stainless Steels

Martensitic stainless steels combine high strength with corrosion resistance. They have a chromium content of 11 - 14% and have a higher carbon content than other stainless steels. Their properties may be summarised as follows:

- **Corrosion resistance** - Martensitics have good corrosion resistance.
  - **Ductility** - Martensitics are less ductile than the other stainless steels.
  - **Tensile Strength** - Martensitics have high tensile and yield strengths. Maximum strength depends upon carbon content and the heat treatment applied.
  - **Hardness** - The hardness of martensitics depends upon carbon content and the heat treatment applied.
- The effect of heat treatment is similar to plain carbon or low alloy steels except that the high alloy content causes transformation to be sluggish, and hardenability to be very high. Consequently martensitics are very sensitive to heat treatment variables.
- **Weldability** - Care is needed during welding due to the detrimental effect of the carbon content.
  - **Magnetism** - Martensitics are magnetic.

**Example Martensitic Grades** are AISI 403, 410 and 416.

# Effects of Alloying Elements

Commonly encountered constituents of stainless steel, both additives and impurities, are listed below. The following table outlines the effect of these elements on the finished stainless steel product and the illustration shows the proportions of the main constituents (chromium, nickel and molybdenum) in some example grades.

- Carbon (C)
- Chromium (Cr)
- Nickel (Ni)
- Manganese (Mn)
- Molybdenum (Mo)
- Titanium (Ti)
- Phosphorus (P)
- Sulphur (S)
- Selenium (Se)
- Niobium (Columbium) (Nb)
- Nitrogen (N)
- Silicon (Si)
- Cobalt (Co)
- Copper (Cu)

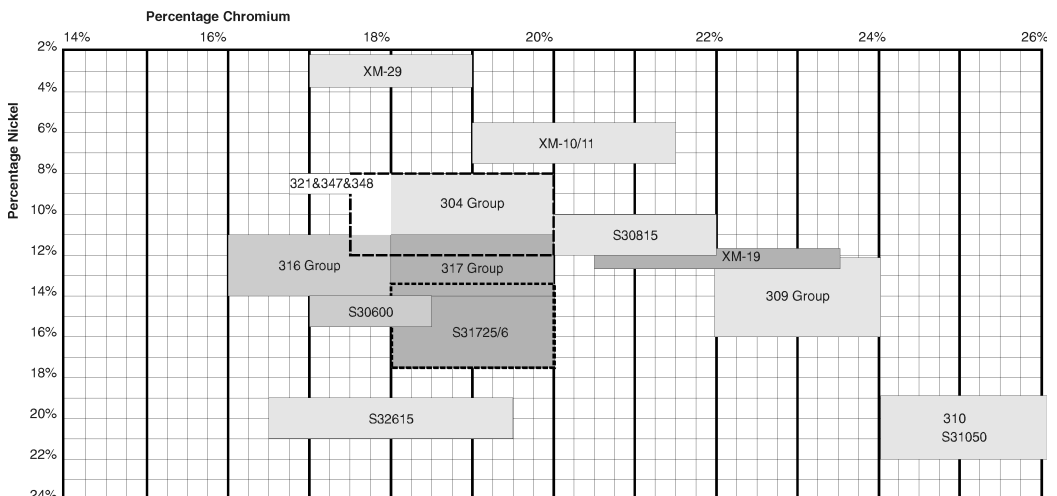
Summary of the effects of alloy elements on the properties of stainless steel

	C	Cr	Ni	S	Mn	Si	P	Cu	Mo	Se	Ti or Nb
Corrosion Resistance	-	↑	↑	↓	-	-	↑	-	↑	-	-
Mechanical Properties	↑	↑	-	-	↑	↑	↑	↑	↑	-	↑
Resistance to High Temperature	-	↑	↑	↓	-	-	-	-	↑	-	↑
Machinability	↓	↓	-	↑	-	-	↑	-	-	↑	-
Weldability	↓	↓	-	↓	↑	-	↓	-	↑	-	↑
Cold Workability	↓	↓	↑	↓	-	-	-	↑	-	-	-

Note

- ↑ = Beneficial, ↓ = Detrimental

## Common stainless steel grades and their chromium, nickel and molybdenum (grey) content



Note

- White = 0% molybdenum, Light grey to dark grey = increasing % of molybdenum

# Grades of Stainless Steel

The following table shows some properties and applications of example stainless steel grades. These are listed in UNS number order.

Refer to page 1-8 for tables of some of the more common international equivalent grades.

**Typical stainless steel grades used for tubular products (UNS number order)**

AISI Grade	UNS	Type <sup>1</sup>	Example properties and applications
-	N08028	A	Wide range of applications. Very good resistance to all kinds of corrosion. High corrosion resistance in strong acids with high resistance to pitting and crevice corrosion. Excellent in phosphoric acid.
-	N08904	A	Very good corrosion resistance in solutions with high chloride, sulphuric and phosphoric content. Applications include refineries and petrochemical industry.
301	S30100	A	High work hardening rate. Used for structural applications where high strength plus high ductility is required.
302	S30200	A	General purpose austenitic with good corrosion resistance. Service temperatures to 800 °C.
303	S30300	A	Free machining form of 302.
304	S30400	A	Low carbon modification of 302 for restriction of carbide precipitation during welding. Good formability. Low pitting corrosion resistance. Wide range of applications including water tubing, automotive exhausts, food processing industries.
304L	S30403	A	Extra low carbon form of 304 for further restriction of carbide precipitation during welding. It has improved resistance to pitting and crevice corrosion in chloride bearing environments. Good forming and machinability characteristics. Applications include brewery, dairy, food processing and pharmaceutical production plant.
304H	S30409	A	Higher temperature version of 304. Most common creep resisting steel with good weldability.
304N	S30451	A	Higher nitrogen than 304 to increase strength with minimum effect on ductility and corrosion resistance. Applications as for 304 but requiring higher strength.
-	S30815	A	Wide range of applications including furnace tubes, recuperators, heat treatment furnaces. Service temperatures up to 1100 °C in air. High creep strength. Small tendency to long term embrittlement at elevated temperatures.
309	S30900	A	High temperature strength and scale resistance.
309S	S30908	A	Low carbon modification of 309. Service temperatures to 1100 °C in air. Good oxidation and sulphidation resistance. Applications include furnaces, heat exchangers, metallurgical plant.
309H	S30909	A	Higher temperature version of 309S.
310	S31000	A	Higher elevated temperature strength and scale resistance than 309.
310S	S31008	A	Low carbon version of 310. Good oxidation and sulphidation resistance. Service temperatures to 1100 °C in air. Some tendency to long term embrittlement at high temperatures.
310H	S31008	A	Higher temperature version of 310S.
-	S31254	SA	Higher strength. Very good resistance to pitting corrosion in seawater and brackish water. Sensitive to segregation in welded condition.
-	S31500	D	Considerably higher strength and lower thermal expansion than austenitic grades. Very high corrosion resistance in chloride containing solutions and weak organic acids. Maximum service temperature 300 °C.
316	S31600	A	Similar to 304. Mo gives higher resistance to general corrosion in non-oxidising acids. It also gives higher resistance to pitting and crevice corrosion, and has higher strength at elevated temperatures. Suitable for applications where chloride contents make 304 unsuitable (i.e. >200mg/l).
316L	S31603	A	Low carbon form of 316. It has improved resistance to pitting and crevice corrosion in chloride bearing environments.
	S31606	A	Similar to 316L.
316H	S31609	A	Higher temperature version of 316. High creep resistance.

# Grades of Stainless Steel

**Typical stainless steel grades used for tubular products (UNS number order) (Continued)**

AISI Grade	UNS	Type <sup>1</sup>	Example properties and applications
316Ti	S31635	A	Similar to 316L. Ti gives good high temperature qualities.
316N	S31651	A	Higher nitrogen than 316 to increase strength with minimum effect on ductility and corrosion resistance. Very high creep resistance/rupture up to 700 °C.
316LN	S31653	A	Higher strength variant of 316L.
317	S31700	A	Higher corrosion and creep resistance than 316.
317L	S31703	A	Extra low carbon version of 317 for restriction of carbide precipitation during welding. Similar to 316L but with further improved corrosion resistance.
-	S31803	D	Duplex steel similar to S32750. Corrosion resistance higher than 316L but lower than S32750.
321	S32100	A	Similar to 304. Stabilised for weldments subject to corrosive conditions. Very good high temperature qualities, with higher strength at elevated temperatures than 304 steels. Contains titanium added in proportion to carbon.
321H	S32109	A	Similar to 321. Higher temperature version.
-	S32304	D	Corrosion resistance comparable to that of 316L, but better resistance to stress corrosion. High yield strength and high abrasion resistance. This duplex steel provides an alternative to most steels giving same strength with lighter weights.
-	S32750	SD	Super duplex steel. Superior corrosion resistance in seawater (stress corrosion cracking). Also high corrosion resistance in organic acids particularly at high concentrations and temperatures in which austenitics would corrode. Higher strength than other duplex steels. Applications include offshore oil and gas exploration, seawater service, refineries, petrochemical plants, pulp and paper industry.
329	S32900	A	Similar to 316 but with better resistance to stress corrosion cracking. Capable of age hardening.
347	S34700	A	Service temperatures to 850 °C in air. 347H available. Applications include superheater tubes in power plants, furnace tubes.
348	S34800	A	Similar to 321. Has low magnetic retentivity. Applications include radioactive systems and nuclear energy uses.
405	S40500	F	Non hardenable grade for assemblies where air hardening grades such as 410 or 403 are not suitable. Applications include petrochemical industry.
409	S40900	F	General purpose construction stainless steel. Applications include car exhaust systems.
410	S41000	M	General purpose heat treatable martensitic grade with 13% chromium giving fair resistance to corrosion. Magnetic. Service temperatures to 750 °C.
429	S42900	F	Improved weldability compared with 430. Applications include nitric acid and nitrogen fixation equipment.
430	S43000	F	General purpose non-hardenable ferritic grade with 17% chromium. Used for decorative tube. Service temperatures to 800 °C.
431	S43100	M	Special purpose hardenable steel used where particularly high mechanical properties are required. Similar to 410 but with higher corrosion resistance and better machinability. Service temperatures to 650 °C.
446-1	S44600	F	High resistance to corrosion and scaling at high temperatures, especially for intermittent service. Often used in sulphur bearing atmosphere. Applications include recuperators, thermocouple protection tubes. Service temperatures to 1150 °C in air.

Note

<sup>1</sup> Type A = Austenitic, SA = Super austenitic, D = Duplex, SD = Super duplex, F = Ferritic, M = Martensitic

# International Equivalent Grades

International equivalents to AISI and UNS designated stainless steel grades (UNS number order)

AISI Grade	UNS	Type	UK	Sweden	Germany		France	Italy	Japan	ISO 2604/1 (Forgings)	International ISO 2604/II (Seamless Tube)	ISO 2604/IV (Welded Tube)
			BS	SIS	W Nr. EN	DIN	Afnor	UNI	JIS			
-	N08028	A	-	2584	1.4563	X1 NiCrMoCu 31-27-4	Z1 NCDU 31-27-03	-	-	-	-	-
-	N08904	A	-	2562	1.4539	X1 NiCrMoCu 25-20	Z1 NCDU 25-20-04	-	-	-	-	-
301	S30100	A	301S21	2331	1.4310	X12 CrNi 17-7	Z12 CN 17-08	X12 CrNi 17-07	SUS 301	-	-	-
302	S30200	A	302S31	2332	-	-	-	-	SUS 302	-	-	-
303	S30300	A	303S31	2346	1.4305	X10CrNiS 18-09	Z10 CNF 18-09	X10 CrNiS 18-09	SUS 303	-	-	-
304	S30400	A	304S15	2333	1.4301	X5 CrNi 18-10	Z6 CN 18-09	X5 CrNi 18-10	SUS 304	F 47	TS 47	TW 47
304	S30400	A	304S16	2340	1.4420	X5 CrNi 18-11	-	X5 CrNi 18-10	SUS 304	-	-	-
304L	S30403	A	304S11	2352	1.4306	X2 CrNi 19-11	Z2 CN 18-10	Z2 CrNi 18-11	SUS 304L	F 46	TS 46	TW 46
304H	S30409	A	-	-	1.4948	X6 CrNi 18-11	-	-	-	-	-	-
304LN	S30453	A	304 S62	2371	1.4311	X2 CrNiN 18-10	Z2CN18-10+N	-	-	-	-	-
-	S30815	A	-	2368	1.4893	-	-	-	-	-	-	-
309S	S30908	A	-	-	1.4833	X7 CrNi 23-14	-	-	-	-	-	-
310H	S31009	A	-	-	-	-	-	-	-	-	-	-
310S	S31008	A	310S24	2361	1.4845	X12 CrNi 25-21	Z12 CN 25-20	X6 CrNi 25-20	SUS 310S	-	-	-
-	S31254	SA	-	2378	1.4529	X1 NiCrMoCuN 25-20-6	Z1 CNDU 20-18-06AZ	-	-	-	-	-
-	S31500	D	-	2376	1.4417	-	Z2 CND 18-05-03	-	-	-	-	-
316	S31600	A	316S31	2347	1.4401	X5 CrNiMo 17-12-2	-	-	-	-	-	-
316	S31600	A	316S33	2347	1.4436	X5 CrNiMo 17-13-3	Z6 CND 17-11	X5 CrNiMo 17-12	SUS 316	F 62	TS 61	TW 61
316L	S31603	A	316S11	2348	1.4404	X2 CrNiMo 17-13-2	Z2 CND 17-12	X2 CrNiMo 17-12	SUS 316L	-	-	-
316L	S31606	A	316S13	2353	1.4435	X2 CrNiMo 18-14-3	Z2 CND 17-13	-	-	F 59	TS 58	TW 58
316H	S31609	A	-	-	-	-	-	-	-	-	-	-
316Ti	S31635	A	320S31	2350	1.4571	X10 CrNiMoTi 18-10	Z6 CNDT 17-12	X6 CrNiMo 17-12	-	-	-	-
316Ti	S31635	A	320S17	-	1.4573	X10 CrNiMoTi 18-12	-	-	-	-	-	-
316Cb	S31640	A	-	-	1.4580	X6 CrNiMoNb 17-12-2	-	-	-	-	-	-
316LN	S31651	A	-	-	1.4961	X8 CrNiNb 16-13	-	-	-	-	-	-
316LN	S31653	A	-	-	1.4406	X2 CrNiMoN 17-12-2	Z2 CND 17-12AZ	-	-	-	-	-
316LN	S31653	A	-	2375	1.4429	X2 CrNiMoN 18-13	-	-	-	-	-	-
317	S31700	A	317S16	2366	1.4449	X5 CrNiMo 17-13	-	X5 CrNiMo 18-15	SUS 317	-	-	-
317L	S31703	A	317S12	2367	1.4438	X2 CrNiMo 18-16-4	Z2 CND 19-15-04	X2 CrNiMo 18-16	SUS 317L	-	-	-
-	S31803	D	-	2377	1.4462	X2 CrNiMoN 22-5-3	Z2 CND 22-05-03	-	-	-	-	-
321	S32100	A	317S31	2337	1.4541	X6 CrNiTi 18-10	Z6 CNT 18-10	X6 CrNiTi 18-11	SUS 321	F 53	TS 53	TW 53
321H	S32109	A	-	-	1.4941	X8 CrNiTi 18-10	-	-	-	-	-	-
-	S32304	D	-	2327	1.4362	X2 CrNiN 23-4	Z2 CN 23-04 AZ	-	-	-	-	-

# International Equivalent Grades

## International equivalents to AISI and UNS designated stainless steel grades (UNS number order) (Continued)

AISI Grade	UNS	Type	UK BS	Sweden		Germany		France Afnor	Italy UNI	Japan JIS	International	
				SIS	W Nr. EN	DIN	ISO 2604/1 (Forgings)				ISO 2604/II (Seamless Tube)	ISO 2604/IV (Welded Tube)
-	S32750	SD	-	2328	1.4410	X2 CrNiMoN 25-7-4	-	-	-	-	-	-
347	S34700	A	347S31	2338	1.4550	X6 CrNiNb 18-10	Z6 CNiNb 18.10	X6 CrNiNb 18-11	SUS 347	F 50, F 51	TS 50	TW 50
403	S40300	M	403S17	2301	1.4000	X7 Cr 13	Z6 C 13	X6 Cr 13	SUS 403	-	-	-
405	S40500	M	-	1.4724	-	X10 CrAl 13	-	-	-	-	-	-
405	S40500	M	405S17	-	1.4002	X7 CrAl 13	Z6 CA 13	X8 CrAl 13	SUS 405	-	-	-
409	S40900	F	-	1.4720	-	X7 CrTi 12	-	-	-	-	-	-
409	S40900	F	409S19	-	1.4512	X6 CrTi 12	-	-	-	-	-	-
410	S41000	M	410S21	2302	1.4006	X10 Cr 13	Z12 C 13	X12 Cr 13	SUS 410	-	-	-
430	S43000	F	430S17	2320	1.4016	X6 Cr 17	Z8 C 17	X8 Cr 17	SUS 430	-	-	-
431	S43100	M	431S29	2321	1.4057	X20 CrNi 17-2	Z15 CN 16-02	X16 CrNi 16	SUS 431	-	-	-
446-1	S44600	F	-	2322	1.4749	-	-	-	-	-	-	-
-	-	-	-	-	1.4306	X2 CrNi 18 10	-	-	-	-	-	-
-	-	-	-	-	1.4401	X5 CrNiMo 17-12-2	-	-	-	F 62	TS 60	TW 60
-	-	-	-	-	1.4404	X2 CrNiMo 17-13-2	-	-	-	-	TS 57	TW 57
-	-	-	-	-	1.4439	X2 CrNiMoN 17-13-5	-	-	-	-	-	-
-	-	-	-	-	1.4510	X6 CrTi 17	-	-	-	-	-	-

## UNS equivalents to selected German Werkstoff Nr. and Swedish SIS grades (W. Nr and SIS number order)

W. Nr.	UNS	W. Nr.	UNS	W. Nr.	UNS	W. Nr.	UNS	W. Nr.	UNS	SIS	UNS	SIS	UNS	SIS	UNS	SIS	UNS
1.4000	S40300	1.4311	S30453	1.4435	S31606	1.4550	S34700	1.4749	S44600	2301	S40300	2333	S30400	2352	S30403	2377	S31803
1.4002	S40500	1.4362	S32304	1.4436	S31600	1.4563	N08028	1.4893	S30815	2302	S41000	2337	S32100	2353	S31606	2378	S31254
1.4006	S41000	1.4401	S31609	1.4438	S31703	1.4571	S31635	1.4941	S32109	2320	S43000	2338	S34700	2361	S31008	2562	N08904
1.4016	S43000	1.4401	S31600	1.4449	S31700	1.4573	S31635	1.4948	S30409	2321	S43100	2340	S30400	2366	S31700	2584	N08028
1.4057	S43100	1.4404	S31603	1.4462	S31803	1.4580	S31640	1.4961	S31651	2322	S44600	2346	S30300	2367	S31703	-	-
1.4301	S30400	1.4406	S31653	1.4512	S40900	1.4720	S40900	-	-	2327	S32304	2347	S31600	2368	S30815	-	-
1.4305	S30300	1.4410	S32750	1.4529	S31254	1.4724	S40500	-	-	2328	S32750	2347	S31600	2371	S30453	-	-
1.4306	S30403	1.4417	S31500	1.4539	N08904	1.4833	S30908	-	-	2331	S30100	2348	S31603	2375	S31653	-	-
1.4310	S30100	1.4429	S31653	1.4541	S32100	1.4845	S31008	-	-	2332	S30200	2350	S31635	2376	S31500	-	-

### Notes

- The above equivalents tables are approximate.

- The exact chemistry of selected grades should be determined in accordance with the manufacturing standard being specified (e.g. the ASTM standards covered in this manual).

# Stainless Steel Grades and ASTM Standards

Each ASTM standard identifies the grades of stainless steel that can be used to fulfil the requirements of that standard. The exact chemical composition of each identified grade is usually defined within the ASTM standard, together with heat analysis and product testing requirements to ensure conformance. As a result of this, the chemical composition of a grade of stainless steel used to make a tubular product may vary slightly depending on the ASTM standard used.

The following table “Stainless steel grades defined or referenced in ASTM pipe, tube and fittings standards”, provides a matrix of the grades of stainless steel used for tubular products and the ASTM standards that define or reference them.

The table “Chemical composition of stainless steel grades used in ASTM standards” on page 1-14, is (except where otherwise stated) based on ASTM A 240/A 240M-96. This is the ASTM standard for heat-resisting chromium and chromium-nickel stainless steel plate, sheet and strip for pressure vessels. It defines the composition of the plate, sheet or strip used in the manufacture of most welded tubular products.

Stainless steel grades defined or referenced in ASTM pipe, tube and fittings standards

AISI Grade	UNS	Type (A=Austenitic, F=Ferritic, D=Duplex, M=Martensitic)	A 182 Forged or rolled flanges etc. for high temperatures	A 213 Seamless ferritic & austenitic tubes	A 240 Heat resisting stainless plate for pressure vessels	A 249 Welded austenitic boiler, superheater, etc tubes	A 268 Seamless and welded ferritic tube, general service	A 269 Seamless & welded austenitic tube, general service	A 270 Seamless & welded austenitic stainless sanitary tube	A 312 Seamless and welded austenitic pipe	A 358 Welded austenitic pipe for high temperatures	A 376 Seamless austenitic pipe for high temperatures	A 403 Wrought austenitic stainless pipe fittings	A 409 Welded large diameter austenitic pipe	A 511 Seamless stainless mechanical tubing	A 554 Welded stainless mechanical tubing	A 632 Seamless & welded austenitic tubing (small diameter)	A 774 As-welded wrought austenitic fittings, general service	A 778 Welded unannealed austenitic stainless tube products	A 789 Seamless and welded duplex tubing	A 790 Seamless & welded duplex pipe	A 791 Welded unannealed ferritic stainless tubing	A 803 Welded ferritic stainless heater tubes	A 813 Single or double welded austenitic pipe	A 814 Cold worked welded austenitic pipe	A 815 Wrought ferritic, duplex and martensitic fittings	A 928 Duplex pipe welded with filler metal	A 943 Spray-formed seamless austenitic pipe	A 949 Spray-formed seamless duplex pipe	A 959 Harmonized standard grade compositions <sup>1</sup>					
	N08367	A																																	
	N08904	A																																	
	N08926	A																																	
16-8-2H	S16800	A																																	
201	S20100	A																																	
202	S20200	A																																	
XM-19	S20910	A																																	
	S21500	A																																	
XM-10	S21900	A																																	
XM-11	S21903	A																																	
XM-29	S24000	A																																	
	S24565	A																																	
	S25700	A																																	
301	S30100	A																																	
302	S30200	A																																	
303Se	S30323	A																																	
304	S30400	A																																	

# Stainless Steel Grades and ASTM Standards

Stainless steel grades defined or referenced in ASTM pipe, tube and fittings standards (Continued)

AISI Grade	UNS	Type (A= Austenitic, F= Ferritic, D= Duplex, M= Martensitic)	A 182 Forged or rolled flanges etc. for high temperatures	A 213 Seamless ferritic & austenitic tubes	A 240 Heat resisting stainless plate for pressure vessels	A 249 Welded austenitic boiler, superheater, etc tubes	A 268 Seamless and welded ferritic tube, general service	A 269 Seamless & welded austenitic tube, general service	A 270 Seamless & welded austenitic stainless sanitary tube	A 312 Seamless and welded austenitic pipe	A 358 Welded austenitic pipe for high temperatures	A 376 Seamless austenitic pipe for high temperatures	A 403 Wrought austenitic stainless pipe fittings	A 409 Welded large diameter austenitic pipe	A 511 Seamless stainless mechanical tubing	A 554 Welded stainless mechanical tubing	A 632 Seamless & welded austenitic tubing (small diameter)	A 774 As-welded wrought austenitic fittings, general service	A 778 Welded unannealed austenitic stainless tube products	A 789 Seamless and welded duplex tubing	A 790 Seamless & welded duplex pipe	A 791 Welded unannealed ferritic stainless tubing	A 803 Welded ferritic stainless heater tubes	A 813 Single or double welded austenitic pipe	A 814 Cold worked welded austenitic pipe	A 815 Wrought ferritic, duplex and martensitic fittings	A 928 Duplex pipe welded with filler metal	A 943 Spray-formed seamless austenitic pipe	A 949 Spray-formed seamless duplex pipe	A 959 Harmonized standard grade compositions <sup>1</sup>
304L	S30403	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
304H	S30409	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	S30415	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
304N	S30451	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
304LN	S30453	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
305	S30500	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
XM-17	S30600	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	S30615	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	S30815	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
309	S30900	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
309S	S30908	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
309H	S30909	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
309Cb	S30940	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
309SCb	S30940	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
309HCb	S30941	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
310	S31000	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
310S	S31008	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
310H	S31009	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
310Cb	S31040	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
310HCb	S31041	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
310HCbN	S31042	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
310MoLN	S31050	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	S31200	D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	S31254	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	S31260	D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	S31272	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	S31500	D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
316	S31600	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
316L	S31603	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
316H	S31609	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
316N	S31651	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
316LN	S31653	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
317	S31700	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
317L	S31703	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	S31725	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	S31726	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	S31803	D	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
321	S32100	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

# Stainless Steel Grades and ASTM Standards

Stainless steel grades defined or referenced in ASTM pipe, tube and fittings standards (Continued)

AISI Grade	UNS	Type (A= Austenitic, F= Ferritic, D= Duplex, M= Martensitic)	A 182 Forged or rolled flanges etc. for high temperatures	A 213 Seamless ferritic & austenitic tubes	A 240 Heat resisting stainless plate for pressure vessels	A 249 Welded austenitic boiler, superheater, etc tubes	A 268 Seamless and welded ferritic tube, general service	A 269 Seamless & welded austenitic tube, general service	A 270 Seamless & welded austenitic stainless sanitary tube	A 312 Seamless and welded austenitic pipe	A 358 Welded austenitic pipe for high temperatures	A 376 Seamless austenitic pipe for high temperatures	A 403 Wrought austenitic stainless pipe fittings	A 409 Welded large diameter austenitic pipe	A 511 Seamless stainless mechanical tubing	A 554 Welded stainless mechanical tubing	A 632 Seamless & welded austenitic tubing (small diameter)	A 774 As-welded wrought austenitic fittings, general service	A 778 Welded unannealed austenitic stainless tube products	A 789 Seamless and welded duplex tubing	A 790 Seamless & welded duplex pipe	A 791 Welded unannealed ferritic stainless tubing	A 803 Welded ferritic stainless heater tubes	A 813 Single or double welded austenitic pipe	A 814 Cold worked welded austenitic pipe	A 815 Wrought ferritic, duplex and martensitic fittings	A 928 Duplex pipe welded with filler metal	A 943 Spray-formed seamless austenitic pipe	A 949 Spray-formed seamless duplex pipe	A 959 Harmonized standard grade compositions <sup>1</sup>			
321H	S32109	A	✓	✓	✓	✓				✓		✓																					
	S32304	D			✓																												
	S32550	D			✓																												
	S32615	A		✓																													
	S32654	A			✓	✓		✓																									
	S32750	D	✓		✓																												
	S32760	D	✓		✓																												
	S32803	F	✓		✓		✓																										
329	S32900	D	✓		✓																												
	S32950	D			✓																												
330	S33000	A																															
	S33100	A	✓																														
	S33228	A	✓	✓																													
	S34565	A	✓	✓	✓	✓																											
347	S34700	A	✓	✓	✓	✓		✓																									
347H	S34709	A	✓	✓	✓	✓																											
347HFG	S3470X	A		✓																													
347LN	S34751	A	✓	✓	✓	✓																											
348	S34800	A	✓	✓	✓	✓		✓																									
348H	S34809	A	✓	✓	✓	✓																											
	S35315	A																															
XM-15	S38100	A		✓	✓	✓		✓																									
	S39274	D																															
	S39277	D	✓																														
403	S40300	M													✓																		
405	S40500	F			✓		✓								✓																		
	S40800	F					✓																										
409	S40900	F			✓		✓																										
410	S41000	M	✓		✓		✓								✓																		
	S41026	M	✓																														
414	S41400	M													✓																		
	S41500	M	✓		✓		✓																										
416Se	S41623	M													✓																		
429	S42900	F	✓		✓		✓								✓	✓																	
430	S43000	F	✓		✓		✓								✓	✓																	
439	S43035	F			✓		✓																										
430Ti	S43036	F					✓								✓																		
431	S43100	M													✓																		



# Chemical Compositions - ASTM A 240

Chemical composition of stainless steel grades used in ASTM standards - based on ASTM A 240/A 240M-96

Grade	UNS	Composition Percentage, max or range																Notes <sup>1</sup>			
		Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	Titanium Ti	Niobium Nb	Tantalum Ta	Nitrogen N	Vanadium Va	Copper Cu	Cerium Ce	Boron Bo		Aluminium Al	Tungsten W	Selenium Se
	N08367	0.030	2.00	0.040	0.030	1.00	23.50-25.50	20.00-22.00	6.00-7.00	-	-	-	0.18-0.25	-	0.75	-	-	-	-	-	-
	N08904	0.020	2.00	0.045	0.035	1.00	23.00-28.00	19.00-23.00	4.0-5.0	-	-	-	0.10	-	1.0-2.0	-	-	-	-	-	-
	N08926	0.020	2.00	0.030	0.010	0.50	24.00-26.00	19.00-21.00	6.0-7.0	-	-	-	0.15-0.25	-	0.5-1.5	-	-	-	-	-	-
201	S20100	0.15	5.50-7.50	0.060	0.030	1.00	3.5-5.5	16.00-18.00	-	-	-	-	0.25	-	-	-	-	-	-	-	-
202	S20200	0.15	7.50-10.0	0.060	0.030	1.00	4.00-6.00	17.00-19.00	-	-	-	-	0.25	-	-	-	-	-	-	-	-
XM-19	S20910	0.06	4.0-6.0	0.04	0.03	0.75	11.5-13.5	20.5-23.5	1.5-3.0	-	-	-	0.20-0.40	0.10-0.30	-	-	-	-	-	-	-
	S21500	0.06-0.15	5.5-7.0	0.04	0.03	0.2-1.0	9-11	14-16	0.8-1.2	-	-	-	-	0.15-0.40	-	-	0.003-0.009	-	-	-	A 213
XM-10	S21900	0.08	8.0-10.0	0.06	0.03	1.00	5.5-7.5	19-21.5	-	-	-	-	0.15-0.40	-	-	-	-	-	-	-	A 269
XM-11	S21903	0.04	8.0-10.0	0.060	0.03	1.00	5.5-7.5	19-21.5	-	-	-	-	0.15-0.40	-	-	-	-	-	-	-	A 269
XM-29	S24000	0.08	11.5-14.5	0.06	0.03	0.75	2.25-3.75	17-19	-	-	-	-	0.2-0.4	-	-	-	-	-	-	-	-
	S24565	0.03	5.0-7.0	0.03	0.01	1.00	16-18	23-25	4.0-5.0	-	-	-	0.4-0.6	-	-	-	-	-	-	-	A 269
301	S30100	0.15	2.00	0.045	0.030	1.00	6.00-8.00	16.00-18.00	-	-	-	-	0.10	-	-	-	-	-	-	-	-
302	S30200	0.15	2.00	0.045	0.030	0.75	8.00-10.00	17.00-19.00	-	-	-	-	0.10	-	-	-	-	-	-	-	-
303Se	S30323	0.15	2.00	0.04	0.04	1.00	8.00-11.00	17.00-19.00	-	-	-	-	0.10	-	-	-	-	-	-	-	0.12-0.2
304	S30400	0.08	2.00	0.045	0.030	0.75	8.00-10.50	18.00-20.00	-	-	-	-	0.10	-	-	-	-	-	-	-	-
304L	S30403	0.030	2.00	0.045	0.030	0.75	8.00-12.00	18.00-20.00	-	-	-	-	0.10	-	-	-	-	-	-	-	-
304H	S30409	0.04-0.10	2.00	0.045	0.030	0.75	8.00-10.50	18.00-20.00	-	-	-	-	0.10	-	-	-	-	-	-	-	-
	S30415	0.04-0.06	0.80	0.045	0.030	1.00-2.00	9.00-10.00	18.00-19.00	-	-	-	-	0.12-0.18	-	-	-	-	-	-	-	-
304N	S30451	0.08	2.00	0.045	0.030	0.75	8.00-10.50	18.00-20.00	-	-	-	-	0.10-0.16	-	-	-	-	-	-	-	-
304LN	S30453	0.030	2.00	0.045	0.03	0.75	8.00-12.00	18.00-20.00	-	-	-	-	0.10-0.16	-	-	-	-	-	-	-	-
305	S30500	0.12	2.00	0.045	0.030	0.75	10.50-13.00	17.00-19.00	-	-	-	-	0.10-0.16	-	-	-	-	-	-	-	-
	S30600	0.18	2.00	0.020	0.020	3.7-4.3	14.0-15.5	17.0-18.5	0.20	-	-	-	-	0.50	-	-	-	-	-	-	-
	S30615	0.16-0.24	2.00	0.03	0.03	3.2-4.0	13.5-16.0	17.0-19.5	-	-	-	-	-	-	-	-	-	0.8-1.5	-	-	-
	S30815	0.05-0.10	0.80	0.040	0.030	1.40-2.00	10.00-12.00	20.00-22.00	-	-	-	-	0.14-0.20	-	-	-	-	-	-	-	-
309S	S30908	0.08	2.00	0.045	0.030	0.75	12.00-15.00	22.00-24.00	-	-	-	-	-	-	-	-	-	-	-	-	-
309	S30900	0.15	2.00	0.045	0.03	1.00	12-15	22-24	-	-	-	-	-	-	-	-	-	-	-	-	A 403
309H	S30909	0.04-0.10	2.00	0.045	0.030	0.75	12.00-15.00	22.00-24.00	-	-	-	-	-	-	-	-	-	-	-	-	-
309Cb	S30940	0.08	2.00	0.045	0.030	0.75	12.00-16.00	22.00-24.00	-	-	-	-	-	-	-	-	-	-	-	-	-
309SCb	S30940	0.08	2.00	0.04	0.03	1.00	12-15	22-24	-	-	-	-	10xC min, 1.10 max	-	-	-	-	-	-	-	A 554
309HCb	S30941	0.04-0.10	2.00	0.045	0.030	0.75	12.00-16.00	22.00-24.00	-	-	-	-	10xC min, 1.10 max	-	-	-	-	-	-	-	-
310	S31000	0.15	2.00	0.04	0.03	0.75	19-22	24-26	-	-	-	-	-	-	-	-	-	-	-	-	A 632

# Chemical Compositions - ASTM A 240

Chemical composition of stainless steel grades used in ASTM standards - based on ASTM A 240/A 240M-96 (Continued)

Grade	UNS	Composition Percentage, max or range																Notes <sup>1</sup>			
		Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	Titanium Ti	Niobium Nb	Tantalum Ta	Nitrogen N	Vanadium Va	Copper Cu	Cerium Ce	Boron Bo		Aluminium Al	Tungsten W	Selenium Se
310S	S31008	0.08	2.00	0.045	0.030	1.50	19.00-22.00	24.00-26.00	-	-	-	-	-	-	-	-	-	-	-	-	-
310H	S31009	0.04-0.10	2.00	0.045	0.030	0.75	19.00-22.00	24.00-26.00	-	-	-	-	-	-	-	-	-	-	-	-	-
310Cb	S31040	0.08	2.00	0.045	0.030	1.50	19.00-22.00	24.00-26.00	-	10xC min, 1.10 max	-	-	-	-	-	-	-	-	-	-	-
310HCb	S31041	0.04-0.10	2.00	0.045	0.030	0.75	19.00-22.00	24.00-26.00	-	10xC min, 1.10 max	-	-	-	-	-	-	-	-	-	-	-
310MoLN	S31050	0.030	2.00	0.030	0.010	0.50	21.00-23.00	24.00-26.00	2.00-3.00	-	-	0.10-0.16	-	-	-	-	-	-	-	-	-
	S31200	0.03	2.00	0.045	0.03	1.00	5.5-6.5	24-26	1.20-2.00	-	-	0.14-0.20	-	-	-	-	-	-	-	-	-
	S31254	0.02	1.00	0.03	0.01	0.80	17.5-18.5	19.5-20.5	6.0-6.5	-	-	0.18-0.22	-	-	0.5-1.0	-	-	-	-	-	-
	S31260	0.03	1.00	0.03	0.03	0.75	5.5-7.5	24-26	2.50-3.50	-	-	0.10-0.30	-	-	0.20-0.80	-	-	-	0.10- 0.50	-	-
	S31272	0.08-0.12	1.5-2	0.03	0.015	0.3-0.7	14-16	14-16	1-1.4	0.3-0.6	-	-	-	-	-	0.004- 0.008	-	-	-	-	A 213
	S31500	0.03	1.20-2.00	0.03	0.03	1.4-2.0	4.25-5.25	18-19	2.50-3.00	-	-	0.05-0.10	-	-	-	-	-	-	-	-	A 790
316	S31600	0.08	2.00	0.045	0.030	0.75	10.00-14.00	16.00-18.00	2.00-3.00	-	-	0.10	-	-	-	-	-	-	-	-	-
316L	S31603	0.03	2.00	0.045	0.030	0.75	10.00-14.00	16.00-18.00	2.00-3.00	-	-	0.10	-	-	-	-	-	-	-	-	-
316H	S31609	0.04-0.10	2.00	0.045	0.030	0.75	10.00-14.00	16.00-18.00	2.00-3.00	-	-	-	-	-	-	-	-	-	-	-	-
316N	S31651	0.08	2.00	0.045	0.030	0.75	10.00-14.00	16.00-18.00	2.00-3.00	-	-	0.10-0.16	-	-	-	-	-	-	-	-	-
316LN	S31653	0.03	2.00	0.045	0.030	0.75	10.00-14.00	16.00-18.00	2.00-3.00	-	-	0.10-0.16	-	-	-	-	-	-	-	-	-
317	S31700	0.08	2.00	0.045	0.030	0.75	11.00-15.00	18.00-20.00	3.00-4.00	-	-	0.10	-	-	-	-	-	-	-	-	-
317L	S31703	0.030	2.00	0.045	0.030	0.75	11.00-15.00	18.00-20.00	3.00-4.00	-	-	0.10	-	-	-	-	-	-	-	-	-
	S31725	0.030	2.00	0.045	0.030	0.75	13.50-17.50	18.00-20.00	4.0-5.0	-	-	0.20	-	-	-	-	-	-	-	-	-
	S31726	0.030	2.00	0.045	0.030	0.75	13.50-17.50	17.00-20.00	4.0-5.0	-	-	0.10-0.20	-	-	-	-	-	-	-	-	-
	S31803	0.030	2.00	0.030	0.020	1.00	4.50-6.50	21.0-23.0	2.50-3.50	-	-	0.08-0.20	-	-	-	-	-	-	-	-	-
321	S32100	0.08	2.00	0.045	0.030	0.75	9.00-12.00	17.00-19.00	-	5x(C+N) min, 0.70 max	-	0.10	-	-	-	-	-	-	-	-	-
321H	S32109	0.04-0.10	2.00	0.045	0.030	0.75	9.00-12.00	17.00-19.00	-	4x(C+N) min, 0.70 max	-	-	-	-	-	-	-	-	-	-	-
	S32304	0.030	2.50	0.040	0.030	1.00	3.00-5.50	21.5-24.5	0.05-0.60	-	-	0.05-0.20	-	0.05-0.60	-	-	-	-	-	-	-
	S32550	0.04	1.5	0.040	0.030	1.0	4.5-6.5	24.0-27.0	2.9-3.9	-	-	0.10-0.25	-	1.5-2.5	-	-	-	-	-	-	-
	S32615	0.07	2.00	0.045	0.030	4.8-6.0	19.0-22.0	16.5-19.5	0.30-1.5	-	-	-	-	1.5-2.5	-	-	-	-	-	-	-
	S32654	0.020	2.00-4.00	0.030	0.005	0.50	21.00-23.00	24.00-25.00	7.00-8.00	-	-	0.45-0.55	-	0.30-0.60	-	-	-	-	-	-	-
	S32750	0.030	1.20	0.035	0.020	0.80	6.00-8.00	24.00-26.00	3.00-5.00	-	-	0.24-0.32	-	0.50	-	-	-	-	-	-	-
	S32760	0.030	1.00	0.030	0.010	1.00	6.00-8.00	24.00-26.00 (Cr + 3.3Mo + 16N = 40 min)	3.00-4.00	-	-	0.20-0.30	-	0.50-1.00	-	-	-	-	-	-	-

# Chemical Compositions - ASTM A 240

Chemical composition of stainless steel grades used in ASTM standards - based on ASTM A 240/A 240M-96 (Continued)

Grade	UNS	Composition Percentage, max or range																Notes <sup>1</sup>				
		Carbon C	Manganese Mn	Phosphorus P	Sulfur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	Titanium Ti	Niobium Nb	Tantalum Ta	Nitrogen N	Vanadium Va	Copper Cu	Cerium Ce	Boron Bo		Aluminum Al	Tungsten W	Selenium Se	
	S32803	0.015	0.50	0.020	0.0035	0.55	3.0-4.0	28.00-29.00	1.8-2.5	-	0.15-0.50 12(C+N) min	-	0.020 (C+N):0.030 max	-	-	-	-	-	-	-	-	
329	S32900	0.08	1.00	0.040	0.030	0.75	2.50-5.00	23.00-28.00	1.0-2.0	-	-	-	-	-	-	-	-	-	-	-	-	
	S32950	0.03	2.00	0.035	0.010	0.60	3.50-5.20	26.00-29.00	1.00-2.50	-	-	-	0.15-0.35	-	-	-	-	-	-	-	-	
330	S33000	0.15	2.00	0.04	0.03	1.00	33-36	14-16	-	-	-	-	-	-	-	-	-	-	-	-	A 554	
	S33228	0.04-0.08	1.00	0.020	0.015	0.030	31.0-33.0	26.0-28.0	-	-	-	-	-	-	0.05- 0.10	-	0.025	-	-	-	-	
347	S34700	0.08	2.00	0.045	0.030	0.75	9.00-13.00	17.00-19.00	-	-	10xC min, 1.00 max	-	-	-	-	-	-	-	-	-	-	
347H	S34709	0.04-0.10	2.00	0.045	0.030	0.75	9.00-13.00	17.00-19.00	-	-	8xC min, 1.00 max	-	-	-	-	-	-	-	-	-	-	
348	S34800	0.08	2.00	0.045	0.030	0.75	9.00-13.00	17.00-19.00	-	-	Nb+Ta: 10xC min, 1.00 max	0.10 max	-	-	-	-	-	-	-	-	-	Cobalt 0.20
348H	S34809	0.04-0.10	2.00	0.045	0.030	0.75	9.00-13.00	17.00-19.00	-	-	Nb+Ta: 8xC min, 1.00 max	0.10 max	-	-	-	-	-	-	-	-	-	Cobalt 0.20
XM-15	S38100	0.08	2.00	0.03	0.03	1.5-2.5	17.5-18.5	17-19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
403	S40300	0.15	1.00	0.04	0.03	0.50	0.50	11.5-13.5	0.60	-	-	-	-	-	-	-	-	-	-	-	-	A 511
405	S40500	0.08	1.00	0.040	0.030	1.00	0.60	11.50-14.50	-	6xC min, 0.75 max	-	-	-	-	-	-	0.10- 0.30	-	-	-	-	-
	S40800	0.08	1.00	0.045	0.045	1.00	0.80	11.5-13.0	-	12xC min, 1.10 max	-	-	-	-	-	-	-	-	-	-	-	A 268
409	S40900	0.08	1.00	0.045	0.030	1.00	0.50	10.50-11.75	-	6xC min, 0.75 max	-	-	-	-	-	-	-	-	-	-	-	-
410	S41000	0.15	1.00	0.040	0.030	1.00	0.75	11.5-13.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
414	S41400	0.15	1.00	0.04	0.03	1.00	1.25-2.50	11.5-13.5	-	-	-	-	-	-	-	-	-	-	-	-	-	A 511
	S41500	0.05	0.5-1.0	0.03	0.03	0.60	3.5-5.5	11.5-14	0.5-1.0	-	-	-	-	-	-	-	-	-	-	-	-	-
416Se	S41623	0.15	1.25	0.06	0.06	1.00	0.50	12-14	-	-	-	-	-	-	-	-	-	-	-	-	-	0.12- 0.20
429	S42900	0.12	1.00	0.040	0.030	1.00	-	14.00-16.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
430	S43000	0.12	1.00	0.040	0.030	1.00	0.75	16.00-18.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
439	S43035	0.07	1.00	0.040	0.030	1.00	0.050	17.00-19.00	-	0.20 + 4(C+N) min, 1.10 max	-	-	0.04	-	-	0.15	-	-	-	-	-	-
430Ti	S43036	0.10	1.00	0.04	0.03	1.00	0.75	16.0-19.5	-	5xC min, 0.75 max	-	-	-	-	-	-	-	-	-	-	-	A 268
431	S43100	0.20	1.00	0.04	0.03	1.00	1.25-2.5	15-17	-	-	-	-	-	-	-	-	-	-	-	-	-	A 511
440A	S44002	0.60-0.75	1.00	0.04	0.03	1.00	-	16-18	0.75	-	-	-	-	-	-	-	-	-	-	-	-	A 511

# Chemical Compositions - ASTM A 240

Chemical composition of stainless steel grades used in ASTM standards - based on ASTM A 240/A 240M-96 (Continued)

Grade	UNS	Composition Percentage, max or range															Notes <sup>1</sup>				
		Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	Titanium Ti	Niobium Nb	Tantalum Ta	Nitrogen N	Vanadium Va	Copper Cu	Cerium Ce		Boron Bo	Aluminium Al	Tungsten W	Selenium Se
18Cr-2Mo	S44400	0.025	1.00	0.04	0.03	1.00	1.00	17.5-19.5	1.75-2.50	Ti+Nb: 0.20-4(C+N) min; 0.80 max	-	0.035	-	-	-	-	-	-	-	-	A 268
443	S44300	0.20	1.00	0.04	0.03	0.75	0.50	18-23	-	-	-	-	-	0.90-1.25	-	-	-	-	-	-	A 268
446-1	S44600	0.20	1.50	0.04	0.03	0.75	0.50	23-30	-	-	-	0.10-0.25	-	-	-	-	-	-	-	-	A 268
446-2	S44600	0.12	1.50	0.04	0.03	0.75	0.50	23-30	-	-	-	0.10-0.25	-	-	-	-	-	-	-	-	A 268
XM-33	S44626	0.06	0.75	0.040	0.020	0.75	0.50	25.00-27.00	0.75-1.50	0.20-1.00 7(C+N) min	-	0.04	-	0.20	-	-	-	-	-	-	-
XM-27	S44627	0.01	0.40	0.020	0.020	0.40	0.50 Ni+Cu 0.50 max	25.00-27.50	0.75-1.50	-	0.05-0.20	0.015	-	0.20	0.05- 0.20	-	-	-	-	-	-
25-4-4	S44635	0.025	1.00	0.040	0.030	0.75	3.5-4.5	24.5-26.0	3.5-4.5	Ti+Nb: 0.20-4(C+N) min; 0.80 max	-	0.035	-	-	-	-	-	-	-	-	-
	S44660	0.030	1.00	0.040	0.030	1.00	1.0-3.50	25.0-28.0	3.00-4.00	Tu+Nb: 0.20-1.00 and 6(C+N) min	-	0.040	-	-	-	-	-	-	-	-	-
29-4	S44700	0.010	0.30	0.025	0.020	0.20	0.15	28.0-30.0	3.5-4.2	-	-	0.020 (C+N): 0.025 max	-	0.15	-	-	-	-	-	-	-
29-4C	S44735	0.030	1.00	0.040	0.030	1.00	1.00	28.00-30.00	3.60-4.20	Ti+Nb: 0.20-1.00 and 6(C+N) min	-	0.045	-	-	-	-	-	-	-	-	-
29-4-2	S44800	0.01	0.30	0.025	0.02	0.20	2.0-2.5	28-30	3.5-4.2	-	-	0.020 (C+N): 0.025 max	-	0.15	-	-	-	-	-	-	-

## Notes

- ASTM numbers are quoted in the Notes column if ASTM A 240/A 240M does not define the grade. See page 1-10 for a matrix of grades against ASTM standards.
- Always use the chemical composition definition contained within the specification (ASTM or otherwise) used to define the tubular product.
- ASTM A 240/A 240M is used as the basis for this table because it contains most of the stainless steel grades available. It is also often referenced by other ASTM standards.

# Chemical Compositions - ASTM A 959

Additional chemical compositions as defined in ASTM A 959-96 Harmonised Standard Grade Compositions for Wrought Stainless Steels

Grade	UNS	Composition Percentage, max or range														Notes					
		Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	Titanium Ti	Niobium Nb	Tantalum Ta	Nitrogen N	Vanadium Va	Copper Cu		Cerium Ce	Boron Bo	Aluminium Al	Tungsten W	Selenium Se
Additional <sup>1</sup> austenitic stainless steel grades:																					
16-8-2H	S16800	0.05-0.10	2.00	0.045	0.030	1.00	7.5-9.5	14.5-16.5	1.50-2.00	-	-	-	-	-	-	-	-	-	-	-	-
201L	S20103	0.03	5.5-7.5	0.045	0.030	1.00	3.5-5.5	16.0-18.0	-	-	-	0.25	-	-	-	-	-	-	-	-	-
201LHN	S20153	0.03	6.4-7.5	0.045	0.015	1.00	4.0-5.0	16.0-17.5	-	-	-	0.10-0.25	-	1.00	-	-	-	-	-	-	-
	S20161	0.15	4.0-6.0	0.045	0.030	3.0-4.0	4.0-6.0	15.0-18.0	-	-	-	0.08-0.20	-	-	-	-	-	-	-	-	-
XM-1	S20300	0.08	5.0-6.5	0.045	0.18-0.35	1.00	5.0-6.5	16.0-18.0	-	-	-	1.75-2.25	-	-	-	-	-	-	-	-	-
	S20400	0.030	7.0-9.0	0.045	0.030	1.00	1.50-3.00	15.0-17.0	-	-	-	0.15-0.30	-	-	-	-	-	-	-	-	-
205	S20500	0.12-0.25	14.0-15.0	0.060	0.030	1.00	1.00-1.75	16.5-18.0	-	-	-	0.32-0.40	-	-	-	-	-	-	-	-	-
XM-31	S21400	0.12	14.0-16.0	0.045	0.030	0.30-1.00	1.00	17.0-18.5	-	-	-	0.35 min	-	-	-	-	-	-	-	-	-
XM-14	S21460	0.12	14.0-16.0	0.060	0.030	1.00	5.0-6.0	17.0-19.0	-	-	-	0.35-0.50	-	-	-	-	-	-	-	-	-
XM-17	S21600	0.08	7.5-9.0	0.045	0.030	1.00	5.0-7.0	17.5-20.5	2.00-3.00	-	-	0.25-0.50	-	-	-	-	-	-	-	-	-
XM-18	S21603	0.03	7.5-9.0	0.045	0.030	1.00	5.0-7.0	17.5-20.5	2.00-3.00	-	-	0.25-0.50	-	-	-	-	-	-	-	-	-
	S21800	0.10	7.0-9.0	0.060	0.030	3.5-4.5	8.0-9.0	16.0-18.0	-	-	-	0.08-0.18	-	-	-	-	-	-	-	-	-
	S28200	0.15	17.0-19.0	0.045	0.030	1.00	-	17.0-19.0	0.75-1.25	-	-	0.40-0.60	-	0.75-1.25	-	-	-	-	-	-	-
302B	S30215	0.15	2.00	0.045	0.030	2.00-3.00	8.0-10.0	17.0-19.0	-	-	-	0.10	-	-	-	-	-	-	-	-	-
303	S30300	0.15	2.00	0.20	0.15 min	1.00	8.0-10.0	17.0-19.0	-	-	-	-	-	-	-	-	-	-	-	-	-
XM-15	S30310	0.15	2.5-4.5	0.20	0.25 min	1.00	7.0-9.0	17.0-19.0	-	-	-	-	-	-	-	-	-	-	-	-	-
XM-2	S30345	0.15	2.00	0.05	0.11-0.16	1.00	8.0-10.0	17.0-19.0	0.40-0.60	-	-	-	-	-	-	-	-	-	-	-	-
	S30430	0.03	2.00	0.045	0.030	1.00	8.0-10.0	17.0-19.0	-	-	-	-	-	3.0-4.0	-	-	-	-	-	-	-
XM-21	S30452	0.08	2.00	0.045	0.030	1.00	8.0-10.0	18.0-20.0	-	-	-	0.16-0.30	-	-	-	-	-	-	-	-	-
304LHN	S30454	0.03	2.00	0.045	0.030	1.00	8.0-11.0	18.0-20.0	-	-	-	0.16-0.30	-	-	-	-	-	-	-	-	-
	S30601	0.015	0.50-0.80	0.030	0.013	5.0-5.6	17.0-18.0	17.0-18.0	0.20	-	-	0.05	-	-	-	-	-	-	-	-	-
308	S30800	0.08	2.00	0.045	0.030	1.00	10.0-12.0	19.0-21.0	-	-	-	0.15-0.35	-	-	-	-	-	-	-	-	-
310HCN	S31042	0.04-0.10	2.00	0.045	0.030	1.00	19.0-22.0	24.0-26.0	-	-	0.20-0.60	-	-	-	-	-	-	-	-	-	-
314	S31400	0.25	2.00	0.045	0.030	1.50-3.00	19.0-22.0	23.0-26.0	-	-	-	-	-	-	-	-	-	-	-	-	-
316Cb	S31640	0.08	2.00	0.045	0.030	1.00	10.0-14.0	16.0-18.0	2.00-3.00	-	10xC-1.10	0.10	-	-	-	-	-	-	-	-	-
316LHN	S31654	0.03	2.00	0.045	0.030	1.00	10.0-13.0	16.0-18.0	2.00-3.00	-	-	0.16-0.30	-	-	-	-	-	-	-	-	-
317LN	S31753	0.030	2.00	0.045	0.030	1.00	11.0-14.0	18.0-20.0	3.0-4.0	-	-	0.10-0.22	-	-	-	-	-	-	-	-	-
	S34565	0.030	5.0-7.0	0.030	0.010	1.00	16.0-18.0	23.0-25.0	4.0-5.0	-	0.10	0.40-0.60	-	-	-	-	-	-	-	-	-
	S35315	0.04-0.08	2.00	0.040	0.030	1.20-2.00	34.0-36.0	24.0-26.0	-	-	-	0.12-0.18	-	-	-	-	-	-	-	-	-
	S38400	0.04	2.00	0.045	0.030	1.00	17.0-19.0	15.0-17.0	-	-	-	-	-	-	-	-	-	-	-	-	-
622	S66220	0.08	1.50	0.040	0.030	1.00	24.0-28.0	12.0-15.0	2.5-3.5	-	1.55-2.00	-	-	0.50	-	0.001-0.010	0.35	-	-	-	-
	S66286	0.08	2.00	0.040	0.030	1.00	24.0-27.0	13.5-16.0	1.00-1.50	-	1.90-2.35	-	0.10-0.50	-	-	0.003-0.010	0.35	-	-	-	-

# Chemical Compositions - ASTM A 959

Additional chemical compositions as defined in ASTM A 959-96 Harmonised Standard Grade Compositions for Wrought Stainless Steels (Continued)

Grade	UNS	Composition Percentage, max or range													Notes						
		Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	Titanium Ti	Niobium Nb	Tantalum Ta	Nitrogen N	Vanadium Va		Copper Cu	Cerium Ce	Boron Bo	Aluminium Al	Tungsten W	Selenium Se
<b>Additional<sup>1</sup> duplex stainless steel grades</b>																					
XM-26	S31100	0.06	1.00	0.045	0.030	1.00	6.0-7.0	25.0-27.0	-	0.25	-	-	-	-	-	-	-	-	-	-	-
	S39277	0.025	0.80	0.025	0.002	0.80	6.5-8.0	24.0-26.0	3.0-4.0	-	-	0.23-0.33	-	1.2-2.0	-	-	-	0.8-1.2	-	-	-
<b>Additional<sup>1</sup> ferritic stainless steel grades:</b>																					
XM-34	S18200	0.08	2.50	0.040	0.15 min	1.00	-	17.5-19.5	1.50-2.50	-	-	-	-	-	-	-	-	-	-	-	-
	S18235	0.025	0.50	0.040	0.15-0.35	1.00	1.00	17.5-18.5	2.00-2.50	0.030-1.00	-	0.025	-	-	-	-	-	-	-	-	C+N = 0.035
409Cb	S40940	0.06	1.00	0.045	0.040	1.00	0.50	10.5-11.7	-	-	10xC-0.75	-	-	-	-	-	-	-	-	-	-
	S40945	0.030	1.00	0.040	0.030	1.00	0.50	10.5-11.7	-	0.05-0.20	0.18-0.40	0.030	-	-	-	-	-	-	-	-	-
	S41045	0.030	1.00	0.040	0.030	1.00	0.50	12.0-13.0	-	-	9x(C+N)-0.60	0.030	-	-	-	-	-	-	-	-	-
	S41050	0.04	1.00	0.045	0.030	1.00	0.60-1.10	10.5-12.5	-	-	-	0.10	-	-	-	-	-	-	-	-	-
	S41603	0.08	1.25	0.06	0.15 min	1.00	-	12.0-14.0	-	-	-	-	-	-	-	-	-	-	-	-	-
430F	S43020	0.12	1.25	0.06	0.15 min	1.00	-	16.0-18.0	-	-	-	-	-	-	-	-	-	-	-	-	-
430FSe	S43023	0.12	1.25	0.06	0.06	1.00	-	16.0-18.0	-	-	-	-	-	-	-	-	-	-	-	-	0.15 min
434	S43400	0.12	1.00	0.040	0.030	1.00	-	16.0-18.0	0.75-1.25	-	-	-	-	-	-	-	-	-	-	-	-
436	S43600	0.12	1.00	0.040	0.030	1.00	-	16.0-18.0	0.75-1.25	5xC-0.80	-	-	-	-	-	-	-	-	-	-	-
442	S44200	0.20	1.00	0.040	0.040	1.00	0.60	18.0-23.0	-	-	-	-	-	-	-	-	-	-	-	-	-
	S44500	0.020	1.00	0.040	0.012	1.00	0.60	19.0-21.0	-	-	10x(C+N)-0.80	0.30	-	0.30-0.60	-	-	-	-	-	-	-
<b>Additional<sup>1</sup> martensitic stainless steel grades:</b>																					
	S41003	0.030	1.50	0.040	0.030	1.00	1.50	10.5-12.5	-	-	-	0.030	-	-	-	-	-	-	-	-	-
410S	S41008	0.08	1.00	0.040	0.030	1.00	-	11.5-13.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	S41026	0.15	1.00	0.02	0.02	1.00	1.00-2.00	11.5-13.5	0.40-0.60	-	-	-	-	0.50	-	-	-	-	-	-	-
410Cb	S41040	0.18	1.00	0.040	0.030	1.00	-	11.5-13.0	-	-	0.05-0.30	-	-	-	-	-	-	-	-	-	-
	S41041	0.13-0.18	0.40-0.60	0.030	0.030	0.50	0.50	11.5-13.0	0.20	-	0.15-0.45	-	-	-	-	-	0.05	-	-	-	-
416	S41600	0.15	1.25	0.06	0.15 min	1.00	-	12.0-14.0	-	-	-	-	-	-	-	-	-	-	-	-	-
XM-6	S41610	0.15	1.50-2.50	0.06	0.15 min	1.00	-	12.0-14.0	-	-	-	-	-	-	-	-	-	-	-	-	-
615	S41800	0.15-0.20	0.50	0.040	0.030	0.50	1.80-2.20	12.0-14.0	0.50	-	-	-	-	-	-	-	-	-	-	-	2.5-3.5
420	S42000	0.15 min	1.00	0.040	0.030	1.00	-	12.0-14.0	-	-	-	-	-	-	-	-	-	-	-	-	-
	S42010	0.15-0.30	1.00	0.040	0.030	1.00	0.35-0.85	13.5-15.0	0.40-0.85	-	-	-	-	-	-	-	-	-	-	-	-
	S42020	0.30-0.40	1.25	0.06	0.15 min	1.00	-	12.0-14.0	0.50	-	-	-	-	-	-	-	-	-	-	-	-
420F	S42023	0.20-0.40	1.25	0.06	0.06	1.00	-	12.0-14.0	0.50	-	-	-	-	-	-	-	-	-	-	-	0.15 min
616	S42200	0.20-0.25	0.50-1.00	0.025	0.025	0.50	0.50-1.00	11.0-12.5	0.90-1.25	-	-	-	0.20-0.3	-	-	-	-	-	-	-	0.90-1.25
440B	S44003	0.75-0.95	1.00	0.040	0.030	1.00	-	16.0-18.0	0.75	-	-	-	-	-	-	-	-	-	-	-	-
440C	S44004	0.95-1.20	1.00	0.040	0.030	1.00	-	16.0-18.0	0.75	-	-	-	-	-	-	-	-	-	-	-	-
440F	S44020	0.95-1.20	1.25	0.06	0.15 min	1.00	-	16.0-18.0	-	-	-	-	-	-	-	-	-	-	-	-	-

# Chemical Compositions - ASTM A 959

Additional chemical compositions as defined in ASTM A 959-96 Harmonised Standard Grade Compositions for Wrought Stainless Steels (Continued)

Grade	UNS	Composition Percentage, max or range														Notes							
		Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	Titanium Ti	Niobium Nb	Tantalum Ta	Nitrogen N	Vanadium Va	Copper Cu		Cerium Ce	Boron Bo	Aluminium Al	Tungsten W	Tungsten W	Selenium Se	
440FSe	S44023	0.95-1.20	1.25	0.06	0.06	1.00	-	16.0-18.0	-	-	-	-	-	-	-	-	-	-	-	-	-	0.15 min	-
	S44025	0.95-1.10	0.30-1.00	0.025	0.025	0.30-1.00	0.75	16.0-18.0	0.40-0.65	-	-	-	-	-	0.50	-	-	-	-	-	-	-	-
XM-32	K64152	0.08-0.15	0.50-0.90	0.025	0.025	0.35	2.00-3.00	11.0-12.5	1.50-2.00	-	-	-	0.01-0.05	0.25-0.40	-	-	-	-	-	-	-	-	-
Precipitation (or age hardening) stainless steel grades:																							
XM-13	S13800	0.05	0.20	0.010	0.008	0.10	7.5-8.5	12.3-13.2	2.00-3.00	-	-	-	0.01	-	-	-	-	0.90-1.35	-	-	-	-	-
XM-12	S15500	0.07	1.00	0.040	0.030	1.00	3.5-5.5	14.0-15.5	-	-	0.15-0.45	-	-	-	2.5-4.5	-	-	-	-	-	-	-	-
632	S15700	0.09	1.00	0.040	0.030	1.00	6.5-7.7	14.0-16.0	2.00-3.00	-	-	-	-	-	-	-	-	0.75-1.50	-	-	-	-	-
630	S17400	0.07	1.00	0.040	0.030	1.00	3.0-5.0	15.0-17.0	-	-	0.15-0.45	-	-	-	3.0-5.0	-	-	-	-	-	-	-	-
635	S17600	0.08	1.00	0.040	0.030	1.00	6.0-7.5	16.0-17.5	-	-	-	-	-	-	-	-	-	0.40	-	-	-	-	-
631	S17700	0.09	1.00	0.040	0.030	1.00	6.5-7.7	16.0-18.0	-	-	-	-	-	-	-	-	-	0.75-1.50	-	-	-	-	-
633	S35000	0.07-0.11	0.50-1.25	0.040	0.030	0.50	4.0-5.0	16.0-17.0	2.5-3.2	-	-	0.07-0.13	-	-	-	-	-	-	-	-	-	-	-
634	S35500	0.10-0.15	0.50-1.25	0.040	0.030	0.50	4.0-5.0	15.0-16.0	2.5-3.2	-	0.10-0.50	-	0.07-0.13	-	-	-	-	-	-	-	-	-	-
XM-25	S45000	0.05	1.00	0.040	0.030	1.00	5.0-7.0	14.0-16.0	0.50-1.00	-	8xC min	-	-	-	1.25-1.75	-	-	-	-	-	-	-	-
XM-16	S45500	0.03	0.50	0.040	0.030	0.50	7.5-9.5	11.0-12.5	0.50	0.80-1.40	0.10-0.50	-	-	-	1.50-2.50	-	-	-	-	-	-	-	-
	S45503	0.010	0.50	0.010	0.010	0.20	7.5-9.5	11.0-12.5	0.50	1.00-1.35	0.10-0.50	-	-	-	1.50-2.50	-	-	-	-	-	-	-	-

Notes

- This table contains only the additional grades defined in ASTM 959-96 compared with those listed on page 1-14 and following. ASTM 959-96 is a recent addition to the Annual Book of ASTM Standards. It contains chemical composition definitions for almost all the grades used in stainless steel tubular products (see page 1-10) and attempts to harmonise those definitions. Always use the chemical composition definition contained within the specification (ASTM or otherwise) used to define the tubular product.

# Chemical Compositions - ISO 2604

Chemical composition of stainless steel grades used in ISO standards - based on ISO 2604/V-1978 (E)

Grade	Composition Percentage, max or range														Notes								
	Carbon C	Manganese Mn	Phosphorus P	Sulphur S	Silicon Si	Nickel Ni	Chromium Cr	Molybdenum Mo	Titanium Ti	Niobium Nb	Tantalum Ta	Nitrogen N	Vanadium Va	Copper Cu		Cerium Ce	Boron Bo	Aluminium Al	Tungsten W	Tungsten W	Selenium Se		
TW46	≤0.03	≤2.00	0.045	0.030	≤1.00	9.00-12.00	17.00-19.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TW47	≤0.07	≤2.00	0.045	0.030	≤1.00	8.00-11.00	17.00-19.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TW50	≤0.08	≤2.00	0.045	0.030	≤1.00	9.00-12.00	17.00-19.00	-	-	≥10xC, <1.00	-	-	-	-	-	-	-	-	-	-	-	-	-
TW53	≤0.08	≤2.00	0.045	0.030	≤1.00	9.00-12.00	17.00-19.00	-	-	≥5xC, <0.80	-	-	-	-	-	-	-	-	-	-	-	-	-
TW57	≤0.03	≤2.00	0.045	0.030	≤1.00	11.00-14.00	16.00-18.50	2.00-2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TW58	≤0.03	≤2.00	0.045	0.030	≤1.00	11.50-14.50	16.00-18.50	2.50-3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TW60	≤0.07	≤2.00	0.045	0.030	≤1.00	10.50-14.00	16.00-18.50	2.00-2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TW61	≤0.07	≤2.00	0.045	0.030	≤1.00	11.00-14.50	16.00-18.50	2.50-3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TW69	≤0.01	≤1.50	0.045	0.030	≤1.00	30.00-35.00	19.00-23.00	-	-	0.15-0.60	-	-	-	-	-	-	-	0.15-0.60	-	-	-	-	-