MACSTEEL VRN

STAINLESS STEEL & ALUMINIUM CATALOGUE

A MACSTEEL GROUP COMPANY

Contents

STAINLESS STEEL

ALUMINIUM

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STAINLESS STEEL

Stainless Steel Service Centre

MACSTEEL VRN operates a specialist stainless steel service centre for the supply of profiled and cut-to-size stainless steel. Cold forming operations to produce sections are also carried out. Purchasing stainless steel, a costly raw material, on a cut-to-size basis offers you many benefits some of which are:

- ➢ You only buy what you need. There is no risk of theft or damage to excess metal as may be the case when purchasing full sheets.
- ➢ Since we are specialists, our scrap rate is lower than yours. Drop outs and off cuts which you cannot use can be used by us on other jobs.
- ➢ No rejects. Errors are our loss; not yours.
- ➢ Better use of manpower and factory space. Rather than using these resources in the operation of cutting machines, put them to use in the business you specialise in. With the same staff and factory space you can obtain greater productivity.
- ➢ No losses through machine failure, absenteeism or part utilisation of facilities.
- ➢ Quality and service is our livelihood. Without it we don't exist, that's why we have to be the best. That's good for you.

Equipment - capability and capacity:

Laser cutting:	Stainless steels 0.7mm - 12mm Carbon steels 1mm - 20mm Brass & Copper 0.5mm - 1.6mm Aluminium 0.5 - 3mm
Plasma cutting:	Bed up to 12 000 x 4 000mm Thickness up to 65mm Cutting tolerance (top surface) ±1mm or + 2mm - 0mm or + 0mm - 2mm Complex shapes; N.C. programming capability.
Guillotining:	Bed up to 6 000mm long. Thickness up to 12mm Cutting tolerance ±0.5mm or + 1mm - 0mm or + 0mm - 1mm
Press brake bending:	Bed up to 12 000m long Thickness up to 12mm

MACSTEEL VRN stainless steel service centre should be regarded as an extension of your operation which means that

- you only pay for what you need.
- you can simplify your business.
- you can improve your productivity.

Rolled Products

The technical data contained in this section relates primarily to grades stocked by MACSTEEL VRN. Additional information on these and other grades can be obtained from MACSTEEL VRN. The data sheets in this section are for sheet and plate to ASTM A240 or ASTM A167. Properties for other product forms may differ slightly from the values given.
Specific requirements for certain industries,

eg i) deep drawing characteristics for holloware manufacturers

ii) gauge tolerance for cutlery manufacturers can be supplied and stocks are held for regular users.

Specifications for Stainless Steel Rolled Products

In South Africa use is made of a number of international specifications. The most common of these are:

ASTM A167	Stainless and heat resisting Chromium-Nickel steel plate, sheet and strip.
ASTM A177	High-strength stainless and heat resisting Chromium-Nickel steel sheet and strip.
ASTM A240	Heat resisting Chromium and Chromium-Nickel stainless steel plate, sheet and strip for Pressure Vessels.
ASTM A480/ A480M	General requirements for flat-rolled stainless and heat resisting steel bars and shapes.
ASTM A276	Stainless and heat resisting steel bars and shapes.
ASTM A484/ A484M	General requirements for stainless and heat resisting bars, billets and forgings.
BS 979 Part 1	Specifications for wrought steels, blooms bars and forgings.
BS 1449 Part 2	Specifications for steel plate, sheet and strip.

Technical Data

Stainless Steel - General

Stainless steel is not a single specific material; it is a name given to a group of corrosion resistant steels normally containing at least 12% chromium and bearing additions of nickel, molybdenum, titanium and niobium. Other elements may also be present. The mechanical properties and behaviours in service of each type of steel depend upon its composition and it is, therefore, important that the correct steel is used for each application.

There are four important classes of stainless steel namely; martensitic, ferritic, austenitic and duplex. The first two types of steel are usually plain chromium steels, commonly having not less than 12% chromium. The martensitic types can be hardened by heat treatment as is the case with plain carbon steels, but ferritic steels, which in general have lower carbon and higher chromium contents than martensitic steels do not respond in this manner. Both martensic and ferritic steels are magnetic. The third category of stainless steel is the austenitic range and these steels contain nickel as well as chromium and are often called 18/8, i.e. 18% chromium and 8% nickel. There are many variations to this composition but it serves as a base to work from.

Austenitic steels, unlike ferritic and martensitic, are non-magnetic and it is not possible to harden them by heat treatment. The only method of hardening these steels is through cold forming or deformation when strain hardening takes place rapidly. The steels can be restored to a fully softened condition by annealing, sometimes referred to as solution treatment.

Duplex stainless steels have structures which are mixtures of austenite and ferrite and have been developed to give a balance between resistance to pitting and stress corrosion cracking. These grades are also substantially stronger than the austenitic grades but the mixed microstructure can represent a problem in hot working.

Stainless steel are mainly used for their corrosion resistant properties and each of the types of steel referred to above has different levels of corrosion resistance.

All stainless steels owe their corrosion resistance to a passive film of submicroscopic thickness (130A) rich in chromium and oxygen. A feature of this film is that it instantly reforms when broken, as long as there is a supply of oxygen available for it to do so. This film forming property is common to all chromium alloys containing more than 11% of that element and it is true of metallic chromium itself. The fact that the passive film is an oxide gives an indication of the corrosion resistance to be expected from stainless steel.

It therefore follows that oxidizing solutions such as dilute nitric acid or ferric-sulphate will tend to keep the film in good repair and protect the underlying metal from corrosion. On the other hand, reducing solutions such as oxalic or hydrochloric acid have a tendency to dissolve the oxygen rich film leading to the metal underneath being attacked. The composition of the film varies with the steel composition and this, together with the fact that there is a low solution rate when the film is broken, enables a wide and useful range of chemicals to be resisted by one or more steels in the three types that have been referred to earlier.

What the major alloying elements do in stainless steel

Chromium	Gives corrosion resistance. Ferrite former.
Carbon	Gives hardness. Powerful austenite former.
Nickel	Gives ductility. Increases high temperature strength. Austenite former.
Manganese	Combines with sulphur to form mang/sulphides which are austenite formers.
Silicon	Increases high temperature strength. Prevents carburization. Ferrite former.
Molybdenum	Increases corrosion resistance and. high temperature strength.
Titanium and Columbium (Niobium)	Stabalises the steel by combining with the carbon.
Sulphur and Selenium	Increase machineability. Lower ductility and corrosion resistance.
Nitrogen **Copper**	Powerful austenite former Increases corrosion resistance for sulphuric applications. Austenite former.

NOMINAL COMPOSITIONS OF SOME OF THE MORE COMMON STAINLESS STEEL

American AISI Type No	% Cr Chromium	% Ni Nickel	% C Carbon	% Mn Manganese	% Si Silicon	% Other N Nitrogen : Mo Molybdenum Ti Titanium : Se Selinium Nb Niobium : S Sulphur
201	16 - 18	3.5-5.5	0.15 max	5.5 - 7.5	1 max	N 0.25 max
202	17 - 19	4 - 6	0.15 max	7.5 - 10	1 max	N 0.25 max
301	16 - 18	6 - 8	0.15 max	2 max	1 max	-
302	17 - 19	8 - 10	0.15 max	2 max	1 max	-
302B	17 - 19	8 - 10	0.15 max	2 max	2 - 3	-
303	17 - 19	8 - 10	0.15 max	2 max	1 max	S 0.15 min
303SE	17 - 19	8 - 10	0.15 max	2 max	1 max	Se 0.15 min
304	18 - 20	8 - 12	0.08 max	2 max	1 max	-
304L	18 - 20	8 - 12	0.03 max	2 max	1 max	-
305	17 - 19	10 - 13	0.12 max	2 max	1 max	-
308	19 - 21	10 - 12	0.08 max	2 max	1 max	-
309	22 - 24	12 - 15	0.2 max	2 max	1 max	-
309S	22 - 24	12 - 15	0.08 max	2 max	1 max	-
310	24 - 26	19 - 22	0.25 max	2 max	1.5 max	-
310S	24 - 26	19 - 22	0.08 max	2 max	1.5 max	-
314	23 - 26	19 - 22	0.25 max	2 max	1.5 - 3	-
316	16 - 18	10 -14	0.08 max	2 max	1 max	Mo 2 - 3
316L	16 - 18	10 -14	0.03 max	2 max	1 max	Mo 2 - 3
317	18 - 20	11 -15	0.08 max	2 max	1 max	Mo 3 - 4
321	17 - 19	9 -12	0.08 max	2 max	1 max	Ti (5 x C) min
347	17 - 19	9 -13	0.08 max	2 max	1 max	Nb + Ta (10 x C) min
348	17 - 19	9 -13	0.08 max	2 max	1 max	Ta 0.1 max & Co 0.2 max
403	11.5 - 13	-	0.15 max	1 max	0.5 max	-
405	11.5 - 14.5	-	0.08 max	1 max	1 max	Al 0.1 - 0.3
409	10.5 - 11.75	-	0.08 max	1 max	1 max	Ti (6 x C) 0.75 max
410	11.5 - 13.5	-	0.15 max	1 max	1 max	-
414	11.5 - 13.5	1.25 - 2.5	0.15 max	1 max	1 max	-
416	12 - 14	-	0.15 max	1.25 max	1 max	S 0.15 min
416Se	12 - 14	-	0.15 max	1.25 max	1 max	Se 0.15 min
420	12 - 14	-	over 0.15	1 max	1 max	-
430	14 - 18	-	0.12 max	1 max	1 max	-
430F	14 - 18	-	0.12 max	1.25 max	1 max	S 0.15 min
430F Se	14 - 18	-	0.12 max	1.25 max	1 max	Se 0.15 min
431	15 - 17	1.25 - 2.5	0.2 max	1 max	1 max	-
440A	16 - 18	-	0.6 - 0.75	1 max	1 max	Mo 0.75 max
440B	16 - 18	-	0.75 - 0.95	1 max	1 max	Mo 0.75 max
440C	16 - 18	-	0.95 - 1.2	1 max	1 max	Mo 0.75 max
442	18 - 23	-	0.2 max	1 max	1 max	-
446	23 - 27	-	0.2 max	1.5 max	1 max	N 0.25 max

APPROXIMATE EQUIVALENTS OF SOME OF THE MORE COMMON TYPES OF STAINLESS STEEL

Old En Nos	USA Canada	United Kingdom	Germany Werkstoff	Germany Din	France	Sweden	Italy UNI	Japan JIS	Euronorm
	201	284 S 16	1.4371	X 12 CrMnNi 18 8 5				SUS 201	
	301	301 S 21	1.4310	X 12 CrNi 17 7	Z 12CN 17-08	14 2331	X 12 CrNi 1707	SUS 301	X 9 CrNi 18-8
58 A	302	302 S 25	1.4300	X 12 CrNi 18 8	Z 10CN 18-08	14 2332	X 10 CrNi 1809	SUS 302	
58 M	303	303 S 22	1.4305	X 10 CrNiS 18 9	Z 10CNF 18-09				X 8 CrNiS 18-9
	303Se	303 S 41			Z 10CNF 18-09	14 2346	X 10 CrNiS 1809		
58 E	304	304 S 15	1.4301	X 5 CrNi 18 10	Z 6CN 18-09	14 2333	X 5 CrNi 1810	SUS 304	X 4 CrNi 18-10
	304L	304 S 11	1.4306	X 2 CrNi 19 11	Z 2CN 18-10	14 2352	X 2 CrNi 1811	SUS 304L	X 2 CrNi 19-11
	305		1.4312		Z 8CN 18-12				
	309	309 S 24	1.4828		Z 15CN 24-13		X 16 CrNi 2314		
	309S								
	310	310 S 24	1.4841		Z 12CN 25-20	14 2361	X 6 CrNi 2520		
	310S		1.4845			14 2361	X 6 CrNi 2520		
58 S	316	316 S 31	1.4401	X 5 CrNiMo 17 12 2	Z 6CND 17-11	14 2343	X 8 CrNiMo 1713	SUS 316	X 4 CrNiMo17-12-2
	316L	316 S 11	1.4435	X 2 CrNiMo 18 14 3	Z 2CND 17-12	14 2348	X 2 CrNiMo 1712	SUS 316L	X 2 CrNiMo 18-14-3
	316Ti	320 S 31				14 2350			
	317	317 S 16	1.4436	X 5 CrNiMo 17 13 3				SUS 317	X 4 CrNiMo 17-13-3
58 C	321	321 S 31	1.4541	X6 CrNiTi 18 10	Z 6CNT 18-12	14 2337	X 6 CrNiTi 1811	SUS 321	X 6 CrNiTi 18-10
58 G	347	347 S 31	1.4550	X 6 CrNiNb 18 10	Z 6CNNb 18-11	14 2338	X 8 CrNiNb 1811	SUS 347	X 6 CrNiNb 18-10
	348								
	403	403 S 17	1.4024	X 15 Cr 13	Z 12 C 13	14 2301		SUS 403	X 15 CR 13
	405	405 S 17	1.4002	X 6 CrA1 13	Z 6CA 13		X 6 CrA1 13	SUS 405	X 6 CrA1 13
	409	409 S 19	1.4512	X 6 CrTi 12					X 2 CrTi 12
56 A	410	410 S 21	1.4006	X 10 Cr 13	Z 12C 13	14 2302	X 12 Cr 13	SUS 410	X 12 Cr 13
56 AM	416	416 S 21	1.4005	X 12 CRS 13			X 12 CrS 13		
56 D	420	420 S 45	1.4021	X 20 Cr 13	Z 20C 13	14 2304	X 30 Cr 13	SUS 420J1	X 20 Cr 13
60	430	430 S 17	1.4016	X 6 Cr 17	Z 8C 17	14 2320	X 8 Cr 17	SUS 430	X 6 Cr 17
	430F		1.4104	X 12 CrMoS 17	Z 10CF 17	14 2383	X 10 CrS 17	SUS 430F	
57	431	431 S 29	1.4057	X 20 CrNi 17 2	Z 15CN 16-02	14 2321	X 16 CrNi 16	SUS 431	
			1.4462	X 2 CrNiMoN 22 5 3	Z 2CND 22-05-03	14 2337			X 2 CrNiMoN 22-5-3
			1.4362	X 2 CrNiN 23 4	Z 2 CN 23-04 AZ	14 2327			X 2 CrNiN 23-4

Rolled Products

Surface Finishes

Mill Finishes

Code for Finish	Description	Remarks
HRA	Hot rolled and annealed.	Industrial heat-resisting applications. Scale impairs corrosion resistance.
No. 1	Hot rolled, annealed and descaled.	Generally used when smoothness and uniformity of finish are not important.
2D	Cold rolled, annealed and descaled.	A uniform, matt finish.
2B	Cold rolled, annealed, descaled and skin passed.	A smooth finish for general applications.
BA	Bright annealed.	The most reflective finish.

Mechanically Polished Finishes

Code for Finish	Description	Remarks
No. 3	Cold rolled, annealed, descaled, polished to 100 grit.	A finished-polished or as a semi-finished-polished surface.
No. 4	Cold rolled, annealed, descaled, polished to 120 grit.	Widely used for restaurant equipment, food processing equipment etc.

Plastic coated stainless steel sheet can be supplied on request.

Physical Properties: Properties at Room Temperature (unless otherwise stated).

	Unit	430	304	316	317L	310	301	3CR12
Density	kg/m³	7 800	7 900	8 000	8 000	7 900	7 900	7 700
Modulus of Elasticity								
Tension	GPa	200	195	195	195	205	200	200
Torsion	GPa	65	85	70	75	70		77
Specific Heat Capacity	J/kg K	460	503	503	503	503	500	480
Thermal Conductity	W/m K							
100°C		21	15.7	14.5	14.5	13.4	16.2	23
300°C		23	17.4	16.4	16.5	15.2	17.9	
500°C		24	21.2	20.0	20.0	18.9	21.5	25
Resistivity	10⁻⁹Ωm	60	70	75	75	80	73	60
Mean Coefficient of Thermal Expansion	µm/m K							
0 - 100°C		10.4	17.0	16.5	16.5	15.5	17.0	9.0
0 - 300°C		11.0	17.75	17.5	17.5	16.5	17.2	
0 - 500°C		11.3	18.5	18.25	18.25	17.25	18.2	12.1
Melting Point	°C	1 425-1 510	1 400-1 450	1 370-1 400	1 370-1 400	1 400-1 455	1 400-1 420	1 430-1 510
Magnetic		Yes	No	No	No	No	No	Yes

Welding

Filler Metals Suggested for Welding Stainless Steels

Type	Condition	Electrode	Remarks
	(In which weldment will be placed in service)	or Filler Rod Type	
AUSTENITIC STAINLESS STEEL			
304	As-welded or fully annealed	308	Type 308 weld metal is also referred to as 18-8 and 19-9 composition. Actual weld analysis requirements are 0.08% max C, 19.0% min Cr and 9.0 min Ni. Type 310 weld metal may be used, but the pickup of silicon from the base metal may result in weld hot cracking.
301 304L	As-welded As-welded or stress-relieved	309L 347 308L	
309 309S	As-welded	309	
310 310S	As-welded	309 310	
316 316L 316Ti 317L	As-welded or fully annealed As-welded or stress relieved As-welded or after stabilizing and stress-relieving heat treatment As-welded or stress-relieved	316 310 316Nb 316L 316Nb 317Nb	Welds make with types 316, 316L 317Nb and 318 electrodes may occasionally display poor corrosion resistance in the "as-welded" condition. In such cases, corrosion resistance of the weld metal may be restored by the following heat treatments: 1) For types 316 and 317L base metal, full anneal at 1065 - 1120°C. 2) For types 316L and 317L base metal, 870°C stress relief 3) For 316Nb base metal, 870 - 900°C stabilizing treatment
321	As-Welding or after stabilizing and stress-relieving heat treatment	347	Type 321 covered electrodes are not regularly manufactured because titanium is not readily recovered during deposition.
FERRITIC STAINLESS STEEL			
430	Annealed As-welded	430 308 309 310	Annealing employed to improve weld joint ductility. Weld metal is soft and ductile, but base metal heat-affected zones have limited ductility.

Welding Guidelines

1. Pre-weld cleaning stainless steel plate with organic solvent or cloth is required.
2. Avoid mild steel contamination.
3. Minimise heat input during welding by correct selection of welding parameters and technique.
4. Post-weld cleaning and passivation is important to ensure optimum corrosion resistance and aesthetic appearance.
   (i) Remove scale from entire weld area, either mechanically or chemically.
   (ii) Mechanical cleaning - Use dedicated discs, iron-free abrasive, e.g. silica sand.
   (iii) Chemical cleaning - Pickle weld with HNO_3 + HF formulation followed by thorough washing with clean cold water.
   (iv) Exercise care during pickling to prevent localised corrosion of the heat-affected zone.
   (v) Passivation of the entire fabrication may be required in marginal applications or to remove mild steel contamination.

TYPICAL APPLICATIONS

Type	Use
301L	Lightweight structural components and panels in transport vehicles. Architectural framework and panelling.
304/304L	Cookware - sinks - cutlery - catering equipment - hospital equipment - food and beverage equipment - abattoir equipment pharmaceutical equipment - cryogenic - pipework, tanks and process vessels for a large variety of corrosive liquids.
309/309S 310/310S	High temperature oxidation (scaling) resistance - good high temperature strength - furnace parts - muffles - radiant tubes.
316/316L/317L	Pipework, tanks, process vessels of more aggressive corrosive liquids and conditions in chemical, petrochemical, pulp and paper, pollution control, hydro metallurgical and petroleum industries.
316Ti/321	Components requiring good elevated temperature strength. Furnace components - afterburners - super heaters - compensators - expansion bellows. Equipment exposed to elevated temperature/aqueous corrosion cycles. (316Ti for the more aggressive corrosive conditions.)
430	Sinks - washtroughs - trim for domestic equipment - kitchen and catering utensils - cutlery. Material handling equipment in sugar and mining industry. Heat resisting and abrasive elevated temperature applications (750°C max.)
3CR12	Ore cars - chutes - launders - buntons - conveyor equipment and systems - tanks. General material handling equipment. Structural applications in corrosive industries - ladders - walkways - cable racks.
SAF2205	Pipework, tanks, process vessels for corrosive conditions beyond general capability of 316/317. Particularly high resistance to pitting and crevice corrosion and chloride induced stress corrosion cracking (SCC).

THEORETICAL MASS: PLATE/SHEET

Note: these values for the theoretical mass of plate and sheet products are not to be referred to for BILLING MASS PURPOSES. This can necessarily only be obtained from specific plates involved, since there is a tolerance on gauge, width and length of all flat products. These tables serve as guidelines only.

9.1 Metric Size Plates
Mass of plate (kg) for plate size (mm x mm)

Gauge	Plate size					
mm	1000 x 2000	1250 x 2500	1500 x 3000	1500 x 5000	1500 x 6000	mass/m²
3.50	57	89	128	213	255	28
4.50	73	114	164	274	328	37
6.00	97	152	219	365	438	49
8.00	130	203	292	487	584	65
10.00	162	253	365	608	730	81
12.00	195	304	438	730	876	97
16.00	260	405	584	973	1 168	130
20.00	324	506	730	1 216	1 460	162
25.00	405	634	912	1 521	1 825	203
30.00	492	769	1 476	1 845	2 214	246

9.2 Metric Size Plates
Mass (kg) for sheet size (mm x mm)

Gauge	Sheet size			
mm	1000 x 2000	1250 x 2500	1500 x 3000	mass/m²
3.00	47.2	73.8	106.2	23.6
2.50	39.3	61.5	88.5	19.7
2.00	31.5	49.2	70.8	15.7
1.50	23.6	36.9	53.1	11.8
1.20	18.9	29.5	42.5	9.4
0.90	14.2	22.1	31.9	7.1
0.70	11.0	17.2	24.8	5.5
0.55	8.7	13.5	19.5	4.3

Tolerances*

Tolerances on Thickness of Hot-Rolled Plates

Specified Thickness (mm)	Thickness Tolerance (mm) Under	Over
2.5	0.23	0.23
3.0	0.25	0.25
3.5	0.30	0.30
4.5	0.36	0.36
6.0	0.25	1.14
8.0	0.25	1.14
10.0	0.25	1.40
12.0	0.25	1.40
16.0	0.25	1.40
20.0	0.25	1.52
25.0	0.25	1.52
30.0	0.25	1.78
32.0	0.25	1.78

Tolerances on Thickness of Cold-Rolled Sheets in Cut Lengths and Coils

Specified Thickness (mm)	Thickness Tolerance (over and under) mm
0.5	0.08
0.7	0.10
0.8	0.10
0.9	0.10
1.0	0.10
1.2	0.13
1.6	0.15
2.0	0.18
2.5	0.23
3.0	0.25

*ASTM A480M - 83a

Note: Tolerance to other specifications available on request.

430 Technical Data

Summary

430 is a low carbon plain chromium ferritic stainless steel. The steel has good corrosion resistance in mildly corrosive environments and good resistance to oxidation at elevated temperatures. In the annealed condition, 430 is ductile, does not harden excessively during cold work and can be formed using a large variety of roll forming or mild stretch-bending operations, as well as the more common drawing and bending processes. The steel has limited weldability and should not be used in the aswelded condition for dynamic or impact loaded structures. Being a ferritic material, 430 is liable to brittle fracture at sub-zero temperatures, and cannot be used in cryogenic applications. As the steel does not contain any nickel or molybdenum, it is cheaper than any of the 300 series steels.

Typical Applications

430 is a simple corrosion and heat-resisting grade and finds application in areas where mildly corrosive conditions occur or where scaling resistance at moderate temperatures is required. Typical applications include: Automotive trim, architectural applications such as industrial roofing and wall cladding, kitchen utensils, sinks, washing machine parts and industrial pipe and tube. Materials handling equipment in the mining and sugar industry. Heat resisting applications up to 759°C.

Chemical Composition

Analysis	C	Mn	P	S	Si	Cr
ASTM A240	0.12 max	1.0 max	0.045 max	0.030 max	1.0 max	16.0 -18.0
Typical	0.05	0.7	0.021	0.024	0.6	17.0

Typical Properties in the Annealed Condition

The properties quoted in this publication are typical of mill product and unless indicated should not be regarded as guaranteed minimum values for design purposes.
For these purposes refer to the relevant specification.

1. Mechanical Properties at Room Temperature

		Typical	Min
Tensile Strength	MPa	530	450
Proof Strength (Offset 0.2%)	MPa	360	205
Elongation (Percent in $L_0=5.65\sqrt{S_0}$)	MPa	25	22
Hardness (Brinell)		160	-

2. Properties at Elevated Temperatures

Short Time Elevated Temperature Tensile Strength

Temperature	°C	300	400	550	650	750
Strength	MPa	450	430	220	120	50

Creep Data

Stress for a creep rate of 1% in 10 000h.

Temperature	°C	550	600	650	700	750
Stress	MPa	50	30	15	5	3

Recommended Maximum Service Temperature

(Oxidising Conditions)

Continuous Service	750°C
Intermittent Service	850°C

Note: Service in the temperature range 425-525°C for over 100 hours will cause the steel to be brittle on cooling to room temperature.

3 Corrosion Resistance

Aqueous

For specific conditions see the publication on Corrosion Resistance of Stainless Steels. If in doubt, consult VRN technical staff. As a rough guide, the following examples are given for certain pure acid-water mixtures:

Temperature°C	20						80					
Concentration –%by mass	1	5	10	20	80	100	1	5	10	20	80	100
Sulphuric Acid	2	2	2	2	2	1	2	2	2	2	2	2
Nitric Acid	0	0	0	0	1	2	0	0	0	1	1	2
Phosphoric Acid	0	0	2	2	1	0	0	0	2	2	1	1
Acetic Acid	0	0	1	1	1	0	0	2	2	2	2	0

Key: 0 = resistant - corrosion rate less than 100 μ/year
1 = partly resistant - corrosion rate 1000 μ/year
2 = non-resistant -corrosion rate more than 1000 μ/year

Atmospheric

The performance of 430 compared with other metals in various environments is shown in the following table. The corrosion rate is based on a 10-year exposure.

Environment	Corrosion Rate (μm/year)		
	430	Aluminium-3S	Mild Steel
Rural	0.0025	0.028	4.3
Marine	0.0381	0.424	25.7
Marine-Industrial	0.0406	0.546	37.1

Note: For corrosion resistance of 430 relative to other types of stainless steel see the publication on Comparative Data.

Welding

430 has adequate weldability for many applications. However it is prone to embrittlement in the weld/haz. The fatigue properties of 430 in the welded condition are poor and it is not recommended for applications where applied tensile or impact loading will be experienced. Consult VRN technical staff for further information. See also the publication on Welding, Brazing and Soldering of Stainless Steels

Thermal Processing

1. **Annealing.** Annealed 430 is in the softest and most ductile condition, and may be used for cold-working operations. The annealing temperature range is 760-850°C followed by cooling in air.
2. **Stress Relieving.** Stress relief after welding or tomming is not usually required, although 200-300°C is the recommended stress-relieving temperature range.
3. **Hot working.** Initial forging and pressing
   Temperature range 1100°C-1150°C
   Finishing temperature below 750°C
   Avoid extended holding times above 1 000°C as excessive grain growth take place, which severally reduces ductility.

Note: Soaking times to ensure uniformity of temperature are longer for stainless steel than for carbon steels. Use up to 1,5 times the time employed for the same thickness of mild steel.

Cold Working

430, being ductile can be readily fabricated by cold working. Typical operations include bending, forming, deep drawing and upsetting.

304/304L Technical Data

Summary

304 is the most versatile and the most widely used of all stainless steels. Its chemical composition, mechanical properties, weldability and corrosion/oxidation resistance provide the best all-round performance stainless steel at relatively low cost. It also has excellent low temperature properties and responds well to hardening by cold working. If intergranular corrosion in the heat-affected zone may occur, it is suggested that 304L be used.

Typical Applications

304 is used in all industrial, commercial and domestic fields because of its good corrosion and heat resisting properties. Some applications include:
Tanks and containers for a large variety of liquids and solids.
Process equipment in the mining, chemical, cyrogenic, food, dairy and pharmaceutical industries.

Chemical Composition (ASTM A240)

	C	Mn	P	S	Si	Cr	Ni
304	0.08max	2.0	0.045	0.030	1.0	18.0 to	8.0 to 10.50
304L	0.03max	max	max	max	max	20.0	8.0-12.0

Typical Properties in the Annealed Condition

The properties quoted in this publication are typical of mill production and unless indicated should not be regarded as guaranteed minimum values for specification purposes.

1. Mechanical Properties at Room Temperature

		304		304L	
		Typical	Min	Typical	Min
Tensile Strength	MPa	600	515	590	485
Proof Stress (Offset 0.2%)	MPa	310	205	310	170
Elongation (Percent in 50mm)		60	40	60	40
Hardness (Brinell)		170	-	170	-
Endurance (fatigue) limit	MPa	240	-	240	-

2. Properties at Elevated Temperatures

All these values refer to 304 only
304L values are not given because its strength decreases markedly above 425°C

Time Elevated Temperature Tensile Strength

Temperature	°C	600	700	800	900	1000
Tensile Strength	MPa	380	270	170	90	50

Creep Data

Stress for a creep rate of 1% in 10 000h.

Temperature	°C	550	600	650	700	800
Stress	MPa	120	80	50	30	10

Maximum Recommended Service Temperature

(Oxidising Conditions)

Continuous Service	925°C
Intermittent Service	850°C

3. Properties at Sub-Zero Temperature (304/304L)

Temperature	°C	-78	-161	-196
Tensile Strength	MPa	1100/950	1450/1200	1600/1350
Proof Stress (Offset 0.2%)	MPa	300/180	380/220	400/220
Impact Strength (Charpy V-Notch)	J	180/175	160/160	155/150

4 Corrosion Resistance

Aqueous

As a rough guide the following examples are given for certain pure acid-water mixtures-

Temperature°C	20						80					
Concentration –% by mass	10	20	40	60	80	100	10	20	40	60	80	100
Sulphuric Acid	2	2	2	2	1	0	2	2	2	2	2	2
Nitric Acid	0	0	0	0	2	0	0	0	0	0	1	2
Phosphoric Acid	0	0	0	0	0	2	0	0	0	0	1	2
Formic Acid	0	0	0	0	0	0	0	1	2	2	1	0

Key: *0 = resistant* *- corrosion rate less than 100 μm/year*
1 = partly resistant *- corrosion rate100 μ to1000 μm/year*
2 = non-resistant *-corrosion rate more than 1000 μm/year*

Atmospheric

The performance of 304 compared with other metals in various environments is shown in the following table - the corrosion rates are based on 10-years exposure.

Environment	Corrosion Rate (μm/year)		
	304	Aluminium-3S	Mild Steel
Rural	0.0025	0.025	5.8
Marine	0.0076	0.432	34.0
Marine Industrial	0.0076	0.686	46.2

Thermal Processing

1. **Annealing.** Heat from 1010°C to 1120°C and cool rapidly in air or water. The best corrosion resistance is obtained when the final annealing is above 1070°C and cooling is rapid
2. **Stress Relieving.** 304L can be stress relieved at 450-600°C for one hour with little danger of sensitisation. A lower stress relieving temperature of 400°C maximum must be used for 304.
3. **Hot working.**
   Initial forging and pressing 1150°C to 1260°C
   Finished temperature 900 to 925°C
   All hotworking operations should be followed by annealing.

Note: Soaking times to ensure uniformity of temperature are longer for stainless steels than for carbon steels - approximately $1^1/_2$ times.

Cold Working

304/304L being extremely tough and ductile, are readily fabricated by cold working. Typical operations include bending, forming, deep drawing and upsetting.

316/316L Technical Data

Summary

316 is an improved version of 304, with the addition of molybdenum and a slightly higher nickel content. The resultant composition of 316 gives the steel much increased corrosion resistance in many aggressive environments. The molybdenum makes the steel more resistant to pitting and crevice corrosion in chloride-contaminated media, sea water and acetic acid vapours. The lower rate of general corrosion in mildly corrosive environments gives the steel good atmospheric corrosion resistance in polluted marine atmospheres.

316 offers higher strength and better creep resistance at higher temperatures than 304. 316 also possesses excellent mechanical and corrosion properties at sub-zero temperatures. When there is a danger of corrosion in the heat-affected zones of weldments, the low-carbon variety 316L should be used. 316Ti, the titanium-stabilised version, is used for its resistance to sensitization during prolonged exposure in the 550°C-800°C temperature range.

Typical Applications

Because of its superior corrosion and oxidation resistance, good mechanical properties and fabricability, 316 has applications in may sectors of industry. Some of these include:
Tanks and storage vessels for corrosive liquids.
Specialised process equipment in the chemical, food, paper, mining, pharmaceutical & petroleum industries.
Architectural applications in highly corrosive environment

Chemical Composition (ASTM A240)

	C	Mn	P	S	Si	Cr	Ni	Mo
316	0.08max	2.0	0.045	0.030	1.0	16.0	10.0	2.00
316L	0.03max	max	max	max	max	to	to	to
316Ti	0.08max					18.0	14.0	3.00

Typical Properties in the Annealed Condition

The properties quoted in this publication are typical of mill products and unless indicated should not be regarded as guaranteed minimum valued for specification purposes.

1. Mechanical Properties at Room Temperature

		316		S316L		316Ti	
		Typ	Min	Typ	Min	Typ	Min
Tensile Strength	MPa	580	515	570	485	600	515
Proof Stress (0.2% offset)	MPa	310	205	300	170	320	205
Elongation (Percent in $L=5.65\sqrt{S_0}$)		55	40	60	40	50	40
Hardness (Brinell)		165	-	165	-	165	-
Erichsen Cup Test Value	mm	8-10	-	10-11	-	-	-
Endurance (fatigue) limit	MPa	260	-	260	-	260	-

2. Properties at Elevated Temperatures

The values given refer to 316 and 316Ti only as strength values for 316L fall rapidly above 425°C

Short Time Elevated Temperature Tensile Strength

Temperature	°C	600	700	800	900	1000
Tensile Strength	MPa	460	320	190	120	70

Creep Data

Stress for a creep rate of 1% in 10 000 hours

Temperature	°C	550	600	650	700	800
Strength	MPa	160	120	90	60	20

Recommended Maximum Service Temperature

(Oxidising Conditions)

Continuous Service	925°C
Intermittent Service	870°C

3. Properties at Sub-Zero Temperature (316)

Temperature	°C	-78	-161	-196
Proof Stress (0.2% Offset)	MPa	400	460	580
Tensile Strength	MPa	820	1150	1300
Impact Strength (Charpy V-Notch)	J	180	165	155

4 Corrosion Resistance

Aqueous

For specific conditions, consult VRN technical staff. As a rough guide, the following examples are given for pure acid-water mixtures.

Temperature°C	20						80					
Concentration (-%by mass)	10	20	40	60	80	100	10	20	40	60	80	100
Sulphuric Acid	0	1	2	2	1	0	2	2	2	2	2	2
Nitric Acid	0	0	0	0	0	1	0	0	0	0	1	2
Phosphoric Acid	0	0	0	0	1	2	0	0	0	0	1	2
Formic Acid	0	0	0	1	1	0	0	0	1	1	1	0

Key: *0 = resistant* *- corrosion rate less than 100 µm/year*
1 = partly resistant *- corrosion rate100 m to1000 µm/year*
2 = non-resistant *-corrosion rate more than 1000 µm/year*

Atmospheric

The performance of 316 compared with other metals in various environments is shown in the following table. Corrosion rates are based on 10-years exposure.

Environment	Corrosion Rate (µm/year)		
	316	Aluminium-3S	Mild Steel
Rural	0.0025	0.025	5.8
Marine	0.0076	0.432	34.0
Marine-Industrial	0.0051	0.686	46.2

Note: For corrosion resistance of SX316 relative to other types, see the section in Comparative Data

Thermal Processing

1. **Annealing.** Heat from 1010°C to 1120°C and cool rapidly in air or water. The best corrosion resistance is obtained when the final annealing temperature is above 1070°C
2. **Stress Relieving.** Heat from 200-400°C and air cool.
3. **Hot working.**
   Initial forging and pressing 1150°C-1200°C
   Finished temperature above 900 °C
   For upsetting operations, forging should be finished between 930 and 980°C

All hotworking operations should be followed by annealing.

Note: Soaking times to ensure uniformity of temperature are up to 1½ times that required for the same thickness of mild steel.

Cold Working

316/316L being extremely tough and ductile, can be readily fabricated by cold working. Typical operations include bending, forming, deep drawing and upsetting.

321 Technical Data

Summary

321 is a titanium-stabilised version of 304, used in particular applications within the sensitizing temperature range. Its resistance to sensitization, coupled with its higher strength at high temperature makes it suitable in application where 304L has insufficient hot strength. It is not subject to weld decay (intergranular corrosion) when exposed to mildly corrosive environments. However, welded 321 must never be used in highly oxidising environments as it is liable to 'knife-line' attack.

Typical Applications

321 is today used almost exclusively for service within the sensitizing temperature range (450-850°C). In welded ambient temperature applications it has been replaced by 304L. Some typical areas of application are:
Furnace components
Superheater and afterburner parts
Compensators and expansion bellows.

Chemical Composition (ASTM A240)

Analysis	C	Mn	P	S	Si	Cr	Ni	Ti
	0.08	2.00	0.045	0.030	1.0	17.0	9.00	5X%C min
	max	max	max	max	max	-19.0	-12.0	0.5max
Typical	0.06	1.2	0.020	0.020	0.5	17.5	9.4	0.48

Typical Properties in the Annealed Condition

The properties quoted in this publication are typical of mill products. Unless otherwise indicated they should not be regarded as guaranteed minimum values for specification purposes.

1. Mechanical Properties at Room Temperature

		Typical	Min
Tensile Strength	MPa	580	515
Proof Strength (0.2% Offset)	MPa	280	205
Elongation (Percent in $L_0=5.65\sqrt{S_0}$)	MPa	60	40
Hardness (Brinell)		163	-
Endurance (fatigue) limit	MPa	260	-

2. Properties at Elevated Temperatures

Short Time Elevated Temperature Tensile Stress

Temperature	°C	600	650	700	750	800	850
Tensile Strength	MPa	390	329	280	230	190	140

Creep Data

Stress to develop a creep rate of 1% in the indicated time at the indicate temperature.

Time	Temperature °C	500	600	650	700	800
10 000h	Stress MPa	180	100	70	40	10
100 000h	Stress MPa	120	80	50	25	5

Creep Rupture Stress

Time	Temperature °C	500	600	650	700	800
1 000	Stress MPa	270	180	140	70	30
10 000h	Stress MPa	240	130	90	50	10
100 000h	Stress MPa	200	90	50	15	5

Recommended Maximum Service Temperature
(Oxidising Conditions)

Continuous	950°C
Intermittent	870°C

Thermal Processing

1. **Annealing Heat** from 1050°C - 1150°C and cool in air. This ensures maximum ductility of the steel.
2. **Stress Relieving** 321 can be stress-relieve annealed within the sensitization temperature range 450-800°C without carbide precipitation occurring, thus avoiding the possibility of intergranular corrosion.
3. **Hot working.**
   Initial forging and pressing
   Temperature 1150°C-1250°C
   Finished temperature 950°C

Note: Soaking times to ensure uniformity of temperature are up to 1½ times that required for carbon steel. Care must be exercised with this grade, and long soaking times to ensure even distribution of carbides should be employed. The initial reductions must be light to allow dispersion of carbides in the flow pattern during forging..

310/310S Technical Data

Summary

310 is a highly alloyed austenitic stainless steel used for high-temperature applications. The high chromium and nickel contents give the steel excellent oxidation resistance as well as high strength at high temperatures. This grade is also very ductile, and has good weldability enabling its widespread usage in many applications.
310S is the low carbon version of 310 and is suggested for applications where sensitisation, and subsequent corrosion by high temperature gases or condensates during shutdown may pose a problem.
310 is manufactured in accordance with ASTM A 167 and 310S to ASTM A 240.

Typical Applications

310/310S find wide application in all high-temperature environments where scaling and corrosion resistance, as well as high temperature strength and good creep resistance are required.

Chemical Composition

	C	Mn	P	S	Si	Cr	Ni
310	0.25 max	2.0	0.045	0.030	1.5	24.0	19.0
310S	0.08 max	max	max	max	max	26.0	22.0

Typical Properties in the Annealed Condition

The properties quoted in this publication are typical of mill production and unless indicated should not be regarded as guaranteed minimum values for specification purposes.

1. Mechanical Properties at Room Temperature

		310		310S	
		Typical	Min	Typical	Min
Tensile Strength	MPa	625	515	575	515
Yield Stress (0.2% Offset)	MPa	350	205	290	205
Elongation (Percent in 50mm)		50	40	50	40
Hardness (Brinell)		172	-	156	-
Endurance (fatigue) limit	MPa	260	-	260	-

2. Properties at Elevated Temperatures

The value quoted are those for 310
Enquire for data on 310S

Short Time Elevated Temperature Tensile Stress

Temperature	°C	550	650	750	850	950	1050
Tensile Strength	MPa	550	430	280	180	90	50

Creep Data

Stress to develop a creep rate of 1% in the indicated time at the indicate temperature.

Time	Temperature °C	550	600	650	700	750	800
10 000h	Stress MPa	110	90	70	40	30	15
100 000h	Stress MPa	90	75	50	30	20	10

Creep Rapture Stress

Time	Temperature °C	600	700	800	900	1000
1 000h	Stress MPa	190	110	50	35	15
10 000h	Stress MPa	170	70	35	20	10
100 000h	Stress MPa	110	55	25	10	2

Recommended Maximum Service Temperature

(Oxidising Conditions)

Continuous	1150°C
Intermittent	1035°C

Thermal Processing

1. **Annealing.** Heat from 1050°C - 1150°C and water quench. This treatment ensures that all carbides are in solution.
2. **Hot working.**
   Initial forging and pressing 1150-1200°C
   Finished temperature above 950°C

Note: Soaking times to ensure uniformity of temperature are up to 1½ times that required for the same thickness of mild steel.

STAINLESS STEEL STOCK

Stock - Stainless Steel Coil

- ➢ Grades and surface finishes not listed, available on request
- ➢ Slit coil can be supplied to meet specific requirements
- ➢ Coil mass - 1 ton nominal, large coils can be supplied
- ➢ Standard coil inside diameter = 610 mm

Thickness (mm)	Width (mm)	Grade	Finish	Theoretical Mass Kg/M
0.5	1000	304	2B	4.46
	1250	304	2B	5.56
0.7	1000	304	2B	5.75
	1250	304	2B	7.19
	1250	430	2B	7.19
0.9	1000	304	2B	7.37
	1000	430	2B	7.37
	1250	304	2B	9.21
	1250	430	2B	9.21
1.2	1000	304	2B	9.72
	1000	430	2B	9.72
	1250	304	2B	12.15
	1250	316	2B	12.15
	1250	430	2B	12.15
	1250	430	BA	12.15
1.6	1000	304	2B	12.96
	1000	316	2B	12.96
	1250	304	2B	16.20
	1250	316	2B	16.20
	1250	430	2B	16.20
2.0	1250	304	2B	20.25
	1250	316	2B	20.25
	1500	304	2B	24.30
2.5	1250	304	2B	25.31
	1250	316	2B	25.31
	1500	304	2B	30.37
3.0	1250	304	2B	30.38
	1250	304L	2B	30.38
	1250	316	2B	30.38
	1250	316L	2B	30.38
	1500	304	2B	36.47
	1500	304L	2B	36.47
	1500	316L	2B	36.47

STAINLESS STEEL ROLLED SECTION STOCK

Stock - ASTM A276

Stainless Steel Round Bar

Size (mm)	Grade			Theoretical mass (kg/mtr)
	304	316	431	
6.0	√	√		0.227
8.0	√	√		0.403
10.0	√	√		0.631
12.0	√	√	√	0.908
12.7	√	√		1.017
13.0	√	√		1.066
14.0	√	√		1.236
16.0	√	√	√	1.615
20.0	√	√	√	2.524
22.0	√	√		3.054
25.0	√	√	√	3.943
26.0	√	√		4.265
28.0	√	√		4.947
30.0	√	√	√	5.679
32.0	√	√		6.461
35.0	√	√	√	7.730
36.0	√	√		8.177
38.0	√	√		9.111
40.0	√	√	√	10.096
45.0	√	√	√	12.777
50.0	√	√	√	15.775
56.0	√	√		19.788
60.0	√	√	√	22.716
65.0	√	√	√	26.659
70.0	√	√	√	30.919
75.0	√	√		35.0
80.0	√	√	√	40.384
85.0	√	√		45.589
90.0	√	√	√	51.111
95.0		√		56.947
100.0	√	√	√	63.100
110.0	√	√		76.351
115.0		√		83.449
120.0		√		90.860
125.0	√	√	√	98.593
130.0		√		106.639
140.0	√	√		123.676
150.0		√	√	141.975
180.0		√		203.0
200.0		√	√	252.400
300.0		√		565.0

Note:
1. *Theoretical Mass = (Diameter)² x 0.00631*
2. *Supplied in 3-6 meter random lengths*

** 431 = EN 57*
Sizes and Grades not listed available on enquiry

STAINLESS STEEL STOCK

Stock - Stainless Steel Sheet

➢ Mechanically polished surface finishes, available on request.

Thickness (mm)	Size (mm)	Grade	Finish	Billing Mass (Kg/sheet)
0.5	2000 x 1000	304	2B	8.07
	2000 x 1000	430	BA	8.07
	2500 x 1250	304	2B	12.61
	2500 x 1250	304	BA	12.61
	2500 x 1250	430	2B	12.61
	2500 x 1250	430	BA	12.61
0.7	2000 x 1000	304	2B	11.3
	2000 x 1000	430	2B	11.3
	2000 x 1000	430	BA	11.3
	2500 x 1250	304	2B	17.65
	2500 x 1250	304	BA	17.65
	2500 x 1250	316	2B	17.65
	2500 x 1250	430	2B	17.65
	2500 x 1250	430	BA	17.65
0.9	2000 x 1000	304	2B	14.53
	2000 x 1000	304	BA	14.53
	2000 x 1000	430	2B	14.53
	2000 x 1000	430	BA	14.53
	2500 x 1250	304	2B	22.7
	2500 x 1250	304	BA	22.7
	2500 x 1250	316	2B	22.7
	2500 x 1250	316L	2B	22.7
	2500 x 1250	430	2B	22.7
	2500 x 1250	430	BA	22.7
1.2	2000 x 1000	304	2B	19.37
	2000 x 1000	316	2B	19.37
	2000 x 1000	430	2B	19.37
	2000 x 1000	430	BA	19.37
	2500 x 1250	304	2B	30.26
	2500 x 1250	304	BA	30.26
	2500 x 1250	316	2B	30.26
	2500 x 1250	430	2B	30.26
	2500 x 1250	430	BA	30.26

➢ Plastic coating available on request

➢ Cut to size service available, by laser, plasma arc and shearing

Thickness (mm)	Size (mm)	Grade	Finish	Billing Mass (Kg/sheet)
1.6	2000 x 1000	304	2B	25.82
	2000 x 1000	316	2B	25.82
	2000 x 1000	430	2B	25.82
	2500 x 1250	304	2B	40.35
	2500 x 1250	304L	2B	40.35
	2500 x 1250	316	2B	40.35
	2500 x 1250	316L	2B	40.35
	2500 x 1250	430	2B	40.35
	2500 x 1250	430	BA	40.35
	3000 x 1500	304	2B	58.1
2.0	2000 x 1000	304	2B	32.28
	2000 x 1000	316	2B	32.28
	2500 x 1250	304	2B	50.44
	2500 x 1250	304L	2B	50.44
	2500 x 1250	316	2B	50.44
	2500 x 1250	316L	2B	50.44
	2500 x 1250	430	2B	50.44
	3000 x 1500	304	2B	72.63
	3000 x 1500	304L	2B	72.63
	3000 x 1500	316	2B	72.63
2.5	2000 x 1000	304	2B	40.35
	2500 x 1250	304	2B	63.05
	2500 x 1250	304L	2B	63.05
	2500 x 1250	316	2B	63.05
	2500 x 1250	316L	2B	63.05
	3000 x 1500	304L	2B	90.79
	3000 x 1500	316L	2B	90.79
3.0	2000 x 1000	304	2B	48.42
	2000 x 1000	304L	2B	48.42
	2000 x 1000	316	2B	48.42
	2000 x 1000	316L	2B	48.42
	2500 x 1250	304	2B	75.66
	2500 x 1250	304L	2B	75.66
	2500 x 1250	316	2B	75.66
	2500 x 1250	316L	2B	75.66
	3000 x 1500	304	2B	108.95
	3000 x 1500	304L	2B	108.95
	3000 x 1500	316	2B	108.95
	3000 x 1500	316L	2B	108.95

STAINLESS STEEL STOCK

Stock - Stainless Steel Plate

- SAF 2205, 904L and other grades not listed, available on request
- All sizes not listed, available on request
- Cut to size service available, by laser, plasma arc and shearing

Thickness (mm)	Size (mm)	Grade	Finish	Billing Mass (Kg/plate)
3.5	3000 x 1500	310S	HRA	127.1
4.5	2000 x 1000	304	No 1	72.63
	2000 x 1000	304L	No 1	72.63
	2000 x 1000	316L	No 1	72.63
	2500 x 1250	304	No 1	113.48
	2500 x 1250	304L	No 1	113.48
	2500 x 1250	316	No 1	113.48
	2500 x 1250	316L	No 1	113.48
	2500 x 1250	321	No 1	113.48
	3000 x 1500	304	No 1	163.42
	3000 x 1500	304L	No 1	163.42
	3000 x 1500	316	No 1	163.42
	3000 x 1500	316L	No 1	163.42
	3000 x 1500	310S	HRA	163.42
	6000 x 1500	304	No 1	326.54
	6000 x 1500	304L	No 1	326.54
	6000 x 1500	316	No 1	326.54
	6000 x 1500	316L	No 1	326.54
6.0	2000 x 1000	304	No 1	96.84
	2000 x 1000	304L	No 1	96.84
	2500 x 1250	304	No 1	151.31
	2500 x 1250	304L	No 1	151.31
	2500 x 1250	316	No 1	151.31
	2500 x 1250	316L	No 1	151.31
	2500 x 1250	321	No 1	151.31
	3000 x 1500	304	No 1	217.89
	3000 x 1500	304L	No 1	217.89
	3000 x 1500	316	No 1	217.89
	3000 x 1500	316L	No 1	217.89
	3000 x 1500	310S	HRA	217.89
	6000 x 1500	304	No 1	435.78
	6000 x 1500	304L	No 1	435.78
	6000 x 1500	316	No 1	435.78
	6000 x 1500	316L	No 1	435.78
8.0	2000 x 1000	304L	No 1	129.12
	2500 x 1250	304	No 1	201.75
	2500 x 1250	304L	No 1	201.75
	2500 x 1250	316	No 1	201.75
	2500 x 1250	316L	No 1	201.75
	2500 x 1250	321	No 1	201.75
	3000 x 1500	304	No 1	290.52
	3000 x 1500	304L	No 1	290.52
	3000 x 1500	316	No 1	290.52
	3000 x 1500	316L	No 1	290.52
	3000 x 1500	310S	HRA	290.52
	6000 x 1500	304	No 1	581.04
	6000 x 1500	304L	No 1	581.04
	6000 x 1500	316	No 1	581.04
	6000 x 1500	316L	No 1	581.04

Thickness (mm)	Size (mm)	Grade	Finish	Billing Mass (Kg/sheet)
10.0	2500 x 1250	304	No 1	252.19
	2500 x 1250	304L	No 1	252.19
	2500 x 1250	316	No 1	252.19
	2500 x 1250	316L	No 1	252.19
	2500 x 1250	321	No 1	252.19
	3000 x 1500	304	No 1	363.15
	3000 x 1500	304L	No 1	363.15
	3000 x 1500	316	No 1	363.15
	3000 x 1500	316L	No 1	363.15
	3000 x 1500	310S	HRA	363.15
	6000 x 1500	304	No 1	726.3
	6000 x 1500	304L	No 1	726.3
	6000 x 1500	316	No 1	726.3
	6000 x 1500	316L	No 1	726.3
12.0	2500 x 1250	304	No 1	302.63
	2500 x 1250	304L	No 1	302.63
	2500 x 1250	316	No 1	302.63
	2500 x 1250	316L	No 1	302.63
	2500 x 1250	321	No 1	302.63
	3000 x 1500	304	No 1	435.78
	3000 x 1500	304L	No 1	435.78
	3000 x 1500	316	No 1	435.78
	3000 x 1500	316L	No 1	435.78
	3000 x 1500	310S	HRA	435.78
	6000 x 1500	304	No 1	871.56
	6000 x 1500	304L	No 1	871.56
	6000 x 1500	316	No 1	871.56
	6000 x 1500	316L	No 1	871.56
16.0	2500 x 1250	304	No 1	403.5
	2500 x 1250	304L	No 1	403.5
	2500 x 1250	316L	No 1	403.5
	3000 x 1500	304L	No 1	581.04
	3000 x 1500	316L	No 1	581.04
18.0	2500 x 1250	304L	No 1	453.94
	2500 x 1250	316L	No 1	453.94
20.0	3000 x 1500	304L	No 1	726.3
	2500 x 1250	316	No 1	504.38
	3000 x 1500	316L	No 1	726.3
22.0	2500 x 1250	304L	No 1	554.81
	2500 x 1250	316L	No 1	554.81
25.0	3000 x 1500	316L	No 1	907.87
	3000 x 1500	304L	No 1	907.87
30.0	3000 x 1500	304L	No 1	1089.45
	3000 x 1500	316L	No 1	1089.45
32.0	2500 x 1250	304L	No 1	807.0
35.0	2500 x 1250	304L	No 1	882.66
	2500 x 1250	316L	No 1	882.66
40.0	2500 x 1250	304L	No 1	1008.75
	2500 x 1250	316L	No 1	1008.75
50.0	2500 x 1250	304L	No 1	1260.99
	2500 x 1250	316L	No 1	1260.99

3CR12

Technical Data

3CR12 General Information

3CR12 is a chromium containing corrosion resisting steel developed as a alternative material of construction where the mechanical properties, corrosion resistance and fabrication requirements of other materials such as mild steel, galvanised or aluminized steel, aluminium or prepainted steels are unsuitable.

3CR12, containing approximately 12% chromium, was designed as a corrosion resisting steel and, as such, will exhibit staining when exposed to aggressive atmospheric conditions. In applications where aesthetic appearance is important, it is recommended that the 3CR12 be painted or that a stainless steel such as AISI Grade 304 be used.

3CR12 is designed with ease of fabrication in mind and its composition and properties result in good forming, drawing, blanking and punching characteristics. The steel is easily welded by any of the recognized welding processes and provided post weld pickling/cleaning and passivation is undertaken, no loss of corrosion resistance in the weld and adjacent areas will result.

As 3CR12 is a recent development, it is not included in any standard structural or vessel design codes. In general, structural design rules for stainless steels are appropriate for 3CR12. When replacing carbon steel with 3CR12, it is necessary to redesign mild and constructional steel components using the improved mechanical and corrosion resisting properties of 3CR12 in order to gain full advantage of potential materials and fabrication savings.

3CR12 has good scaling resistance up to 600°C and useful mechanical properties up to about 450°C.

Applications for 3CR12 exist in the following industries:

- mining and minerals processing
- sugar
- civil engineering
- chemical and petro-chemical
- pulp and paper
- sewerage and waste treatment

For more information and discussion on applications, please contact VRN technical staff.

Properties of 3CR12

Note: 3CR12 is a proprietary grade alloy and is manufactured according to a Columbus Stainless specification.

Chemical Composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni
0.03 max	1.0 max	1.5 max	0.04 max	0.015 max	10.5 - 12.5	0.2 - 1.0

1. Mechanical Properties

Ultimate Tensile Strength (Transverse)	460MPa min
0.2% Offset Proof Strength (Transverse)	< 6mm thick - 280 MPa min
	⩾ 6mm thick - 320 MPa min
Elongation (Transverse)	⩽ 6mm thick - 18% min
	> 6mm thick - 20% min
Hardness	⩽ 12.0mm thick - 220 Brinell max
	> 12.0mm thick - 250 Brinell max
Impact Toughness at 20°C Charpy V	35 J min

2. Properties at Elevated Temperatures

3CR12 contains 11-12% chromium and thus has reasonably good oxidation resistance at moderately high temperatures. Although not designed as a high temperature steel, 3CR12 does have useful mechanical properties at temperatures where mild or carbon manganese steels would be unsuitable.

The recommended maximum service temperatures, for 3CR12 are:

Continuous Service	600°C
Intermittent Service	750°C

3CR12 is suitable for use only under oxidising or neutral conditions and is not suited to reducing atmospheres. Up to 500°C, creep can be ignored with 3CR12 but over 500°C there is a rapid fall off in mechanical properties. At these higher temperatures the standard heat resisting grades of steel should be considered.

VRN Technical staff should be contacted for further information.

3. Fatigue Strength

The fatigue strength of 3CR12 is similar to that of carbon manganese steels for similar joints. The attention of designers is drawn to good fatigue design practice and adequate care should be taken to avoid stress raisers, sudden thickness changes, etc. It is strongly recommended that standard codes be used (such as British Standard BS 5400 - 1980) for the design of fatigue loaded structures.

Cognisance must be taken of 3CR12's heat affected zone properties, when using a welded assembly under cyclic loading conditions.

More detailed data is available from VRN.

3CR12 continued

4. Physical Properties

All values given are for 20°C unless otherwise specified.

Density		7680 kg/m³
Elastic Modulus (Tension)		200 GPa
Poisson's Ratio		0.3
Specific Heat Capacity		480 J/kg K
Thermal Conductivity	100°C	30.0 W/m K
	500°C	40.0 W/m K
Electrical Resistivity		66 x 10^{-9}Ωm
Mean co-efficient of	0-100°C	11.1 μm/mK
thermal expansion	0-300°C	11.7 μm/mK
	0-500°C	12.3 μm/mK
Melting Range		1 430 - 1 510°C
Relative Permeability		Ferromagnetic

5. Corrosion Resistance

3CR12 with 12% chromium as its major alloying element, is not intended as a material for use in contact with process solutions such as acids, salts, etc. It is more suited to applications involving ancillary equipment on process plants such as cable racking, stairways, flooring, hand-railing, etc. 3CR12 is a "corrosion resistant" rather than "stainless" steel and as such, will tend to form a light, surface rust or discolouration when exposed to aggressive environments. This patina is superficial and does not affect the mechanical properties of the steel.

Should aesthetic or hygienic qualities be of prime importance, stainless steels rather than 3CR12 should be considered, although 3CR12 can be successfully painted with a number of paint systems.

Aqueous Corrosion

It is recommended that consultations be held with technical staff on the use of 3CR12 in water. 3CR12 performs quite satisfactorily in domestic waters or where chloride contents are fairly low. However in applications involving high chloride levels detailed testing of the water may be necessary and technical staff should be consulted.

At the design stage, efforts must be made to avoid crevices, sedimentation, stagnancy, high operating temperatures etc. as these facts will have a negative impact on the performance of the steel.

3CR12 is not recommended for use in hot water systems unless detailed testing has previously been carried out.

Atmospheric Corrosion

A long term atmospheric corrosion programme conducted over 10 years by the CSIR has shown 3CR12 to have very good atmospheric corrosion resistance. Data on the performance of various materials at different test sites is available from VRN Technical staff.

6. Fabrication of 3CR12

Note: A detailed 3CR12 fabrication guideline is available.

Cutting

For general fabrication requirements, the most effective cutting methods are:

Abrasive disc
- use dedicated discs
- avoid overheating
- vitrified or resinoid aluminium oxide discs recommended

Plasma
- oxygen-free nitrogen is the most economical primary cutting gas. (Other gasses can be used)
- welding Grade CO^2 is an economical shielding gas. (Others can be used)
- heat discolouration must be removed prior to use in a corrosive environment

Guillotine
- use well sharpened and correctly aligned and set blades to avoid sheared breaks and rollover
- capacity of guillotine (rated in terms of mild steel thickness) must be down-rated by 40% for 3CR12

Forming

It is important to note that due to the higher proof strength of 3CR12, more power is required for most forming operations, than would be needed for mild steel.

When bending 3CR12 it is important to maintain a minimum innerbend radius equal to twice the material thickness. Reverse bending at ambient temperatures is not recommended - the bend area should be preheated to ±150°C. Edge cracks can be avoided by placing the cut face on the outside radius of the bend and the sheared face on the inside. This type of cracking can also be prevented by grinding the outside radius point of bending into a rounded profile, thus eliminating the natural stress concentration point.

Welding

Manual metal arc, metal inert gas and tungsten inert gas are the common procedures used.

All welding procedures must ensure that heat inputs are kept to a minimum. Down-hand welding is the preferred welding position and bead runs rather than weaving should be used. Austenitic stainless steel filler metals such as AWS ER 309L, 308L or 316L should be used.

In order to ensure adequate corrosion resistance in weld zones, it is necessary to remove all heat tint by pickling or by some mechanical means and passivating with a cold 10% nitric acid solution after cleaning. Thorough washing with clean, cold water after pickling and passivating is essential.

3CR12 continued

Machining

In the annealed condition, 3CR12 has machining characteristics similar to AISI 430 i.e. a machinability rating of 60. The reduced extent of work-hardening compared to austenitic stainless steel eliminates the need for special cutting tools and lubricants. Slow speeds and heavy feeds with sufficient emulsion lubricant will prevent machining problems.

Fastening

Where 3CR12 sections are to be bolted, stainless steel fasteners such as type 304 or 431 are preferred. If bolted structures are to be used in humid or wet environments, it is strongly recommended that compressible, non-absorbent gaskets such as rubber be used.

Thermal Processing

Annealing

3CR12 is supplied in the annealed condition, its softest and most ductile state. After severe cold forming operations or after hot forming operations above 750°C, annealing may be required. Annealing is carried out at 700-750°C followed by air cooling. Soaking times are $1\frac{1}{2}$ hours per 25mm section.

Stress Relieving

Stress relieving is not recommended for 3CR12. If it is essential, temperatures of not more than 450°C should be employed.

Hot Working

Any hot forming should preferably be conducted at temperatures between 900 and 1 000°C with a finishing temperature of below 800°C. Annealing is essential after hot working operations.

Other Products

- Flat Bar - deburred and straightened after cutting from plate.
- Sections - cold formed, customised sections.
- Pipe - longitudinal and spiral welded 3CR12 pipe is available.
- HRA surface finish also available

Stock

3CR12 Sheet and Plate

Gauge (mm)	Size 2 500 x 1 250		3 000 x 1 500		6 000 x 1 500		Surface Finish
	Stock	Kg/Plate	Stock	Kg/Plate	Stock	Kg/Plate	
1.0	√	25					2B
1.2	√	30					
1.6	√	40					
2.0	√	50	√	72			
2.5	√	62.5	√				
3.0	√	75	√	108	√	216	No 1
3.5	√	87.5	√	126	√	252	
4.5	√	112.5	√	162	√	324	
6.0	√	150	√	216	√	432	
8.0	√	200	√	288	√	576	
10	√	250	√	360	√	720	
12	√	300	√	432	√	864	
16	√	400	√	576			
20	√	500	√	720			
25			√	900			
30	√	750	√	1 080			

- Tolerance usually in accordance with ASTM A480M
- Coil of cold rolled 3CR12 available subject to enquiry
- Alternative gauges and sizes available subject to enquiry

Pipe, Tube and Fittings

Technical

Standard and Specifications

In South Africa, a large number of national and international standards for the specification of stainless steel pipe and tube are used.

The more common standards are:

ASTM A213

Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater and Heat-Exchanger Tubes

This specification covers minimum-wall-thickness, seamless, ferritic and austenitic steel, boiler and superheater tubes and austenitic steel heat-exchanger tubes, designated Grades T5, TP 304, etc.

Grades TP 304H, TP 304N, TP 316H, TP 316N, TP 321H, TP 347H and TP 348H are modifications of Grades TP 304, TP 316, TP 321, TP 347 and TP 348 and are intended for high-temperature service such as for super-heaters and reheaters.

The tubing sizes and thicknesses usually furnished to this specification are 3,2mm in inside diameter to 127mm in outside diameter and 0.38 to 12.70mm, inclusive, in minimum wall thickness. Tubing having other dimensions may be furnished, provided such tubes comply with all other requirements of this specification.

Mechanical property requirements do not apply to tubing smaller than 3.2mm in inside diameter or 0.38mm in thickness.

An optional supplementary requirement is provided and, when desired, shall be so stated in the order.

ASTM A249

Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger and Condenser Tubes

This specification covers nominal-wall-thickness welded tubes made from austenitic steels with various grades intended for such use as boiler, superheater, heat-exchanger or condenser tubes

Grades TP 304H, TP 304N, TP 316H, TP 316N, TP 321H, TP 347H and TP 348H are modifications of Grades TP 304, TP 316, TP 321, TP 347 and TP 348 and are intended for high-temperature service such as for super-heaters.

The tubing sizes and thickness usually furnished to this specification are 3.2mm in inside diameter to 127mm in outside diameter and 0.38 to 8.13mm inclusive in wall thickness. Tubing having other dimensions may be furnished, provided such tubes comply with all other requirements of this specification.

Mechanical property requirements do not apply to tubing smaller than 3.2mm in inside diameter or 0.38mm in thickness.

Optional supplementary requirements are provided and, when one or more of these are desired, each shall be so stated in the order.

ASTM A268

Standard Specification for Seamless and Welded Ferritic Stainless Steel Tubing for General Service

This specification covers a number of grades of nominal-wall-thickness stainless steel tubing for general corrosion-resisting and high-temperature service. These grades are commonly known as the "straight-chromium" types and are characterised by being ferromagnetic. Two of these grades, TP 410 and TP 429 are amenable to hardening by heat treatment, and the high chromium, ferritic alloys are sensitive to notch-brittleness on slow cooling to ordinary temperatures. These features should be recognised in the use of these materials. Grade TP XM-8 is used primarily for hot-water tank service and does not require post-weld heat treatment to prevent attack of the heat affected zone. An optional supplementary requirement is provided, and when desired shall be so stated in the order.

Note: For tubing smaller than 12.7mm in outside diameter, the elongation values given for strip specimens shall apply. Mechanical property requirements do no apply to tubing smaller than 3.2mm in outside diameter or with walls thinner than 0.38mm.

ASTM A269

Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

This specification covers grades of nominal-wall-thickness, stainless steel tubing for general corrosion-resisting and low- or high-temperature service.

The tubing sizes and thicknesses usually furnished to this specification are 6.4mm in inside diameter and larger and 0.51mm in nominal-wall-thickness and heavier.

Mechanical property requirements do not apply to tubing smaller than 3.2mm in inside diameter or 0.38mm in thickness.

Optional supplementary requirements are provided and, when one or more of these are desired, each shall be so stated in the order.

ASTM A312

Standard Specification of Seamless and Welded Austenitic Stainless Steel Pipe

This specification covers seamless and straight-seam welded austenitic steel pipe intended for high-temperature and general corrosive service.

Technical

Note: When the impact test criterion for a low-temperature service would be 20J energy absorption or 15 mils lateral expansion, some of the austenitic stainless steel grades covered by this specification are accepted by certain pressure vessels or piping codes without the necessity of making the actual test. For example, Grades 304, 304L and 347 are accepted by the ASME Pressure Vessel Code, Section VIII Division 1, and by the Chemical Plant and Refinery Piping Code, ANSI B31.3 for service at temperatures as low as -254°C without qualification by impact tests. Other AISA

continued on next page

stainless steel grades are usually accepted for service temperatures as low as -198°C without impact testing. Impact testing may, under certain circumstances, be required.

For example, materials with chromium or nickel content outside the AISI ranges, and for material with carbon content exceeding 0.10% are required to be impact tested under the rules of ASME Section VIII Division 1 when service temperatures are lower than -46°C.

Grades TP 304H, TP 304N, TP 316H,TP 316N, TP 321H, TP 347H and TP 348H are modifications of Grades TP 304, TP 316, TP 321, TP 347 and TP 348 and are intended for high-temperature service.

Optional supplementary requirements are provided for pipe where a greater degree of testing is desired. These supplementary requirements call for additional tests to be made and, when desired, one or more of these may be specified in the order.

Technical

Other standards for stainless steel pipe and tube which may be used are listed below:

ISO 1127 - Stainless Steel tubes.
ANSI B36-19 - Seamless and welded stainless steel pipe $^1/_8$"-30". Schedule 5S, 10S 40S & 80S.
DIN 2462 - Seamless stainless steel tube.
DIN 2463 - Welded stainless steel tube.
DIN 2464 - Seamless stainless steel precision tube.
DIN 17440 - Stainless steels (Including tubular product form).
BS 3605 - Seamless and welded austenitic stainless pressure vessel tubes and pipes (Includes spiral welded pipe).
BS 4825 - Stainless steel pipes and fittings for the food industry.
SABS 965 - Tube for domestic water service.
ASTM A270 - Standard specification for seamless and welded stainless steel sanitary tubing.
ASTM A271 - Standard specification for seamless austenitic chromium nickel steel still tubes for refinery service.
ASTM A688 - Standard specification for welded austenitic stainless steel feedwater heater tubes.
ASTM A450 - Standard specification for general requirements for carbon, ferritic alloy and austenitic alloy steel tubes.
ASTM A358 - Standard specification for electric fusion welded austenite chromium nickel alloy steel pipe for high temperature service.
ASTM A409 - Standard specification for welded large diameter austenitic steel pipe for corrosive or high temperature service.
ASTM A731 - Standard specification for seamless and welded ferritic stainless steel pipe.
ASTM A530 - Standard specification for general requirements for specialised carbon and alloy steel pipe.

ASME Part II (Materials) Standard correspond in the main to the ASTM standards and are indicated SA ...
eg. ASTM A312 ASME SA312

For additional information please contact the VRN Technical staff

Piping Design and Pressure Estimation

The rules for designing a piping system are given in various national codes, eg. ANSI B31, BS 3351, ASME Section 3.

The code specifications which are applicable will be determined by the general service for the piping system and will dictate the minimum requirements in respect of dimensional standards, materials etc.

Flow rate, pressure drop, external forces, thermal stresses and deadweight are some of the parameters to be taken into account.

Two useful computations which can be used for seamless and welded pipe, but which are not substitutes for design codes are:

$$\text{Wall Thickness } T = \frac{PD}{2C + 2YP} + C$$

$$\text{Internal Pressure } P = \frac{2S\,(T-C)}{D-2Y\,(T-C)}$$

Where: T = design thickness of the pipe ($12^1/_2$% less than the nominal wall thickness of any given pipe size), inches
P = internal design pressure, PSIG
D = outside diameter of pipe, inches
S = allowable stress of materials at service temperature, PSI
C = allowance for mechanical and corrosion, inches (zero for our calculations)
Y = a coefficient having values as follows:
For austenitic stainless steels -
0.4 up to and including 1 050°F
0.5 for 1 100°F
0.7 for 1 150°F and above
For non ferrous metals -
0.4 up to and including 900°F

Note: Conversion Factors
1 Bar = 14.5psi 1 inch = 25.4mm
1MPa = 10 Bars = 145psi °F = (°C x 9/5) + 32

For allowable stress, S

Temp. °F	Grade				
	304L	304	316L	316	321
	(Psi)	(304L value multiplied by)			
Up to 300°F	14 200	x 1.20	x 1.00	x 1.20	x 1.20
400°F	13 400	x 1.19	x 0.98	x 1.22	x 1.18
500°F	12 500	x 1.18	x 0.98	x 1.22	x 1.17
600°F	11 850	x 1.18	x 0.97	x 1.22	x 1.17

Stainless Product Cross Index - ASTM Standards

Type	Pipe	Welding Fittings[1]	Flanges
Type 304 18 Cr-8 Ni	A312-TP304 A358-304 A376-TP304	A403-WP304	A182-F304
	A312-TP304H A376-TP304H A430-FP304H	A403-WP304H	A182-F304H
	A312-TP304L	A403-WP304L	A182-F304L
Type 309 23 Cr-12 Ni	A312-TP309 A358-309	A403-WP309	A314-309
Type 310 22 Cr-20 Ni	A312-TP310 A358-310	A403-WP310	A182-F310
Type 316 16 Cr-13 Ni with 2½Mo	A312-TP316 A358-316 A376-TP316	A403-WP316	A182-F316
	A312-TP316H A376-TP316H A430-FP316H	A403-WP316H	A182-F316H
	A312-TP316L	A403-WP316L	A182-F316L
Type 317 16 Cr-13 Ni with 3½Mo	A312-TP317	A403-WP317	A314-317
Type 321 18 Cr-8 Ni with Ti	A312-TP321 A358-321 A376-TP321	A403-WP321	A182-F321
	A312-TP321H A376-TP321H A430-FP321H	A403-WP321H	A182-F321H
Type 347 18 Cr-8 Ni with Ta-Cb	A312-TP347 A358-347 A376-TP347	A403-WP347	A182-F347
	A312-TP347H A376-TP347H A430-FP347H	A403-WP347H	A182-F347H
Type 348 18 Cr-8 Ni with Cb	A312-TP348 A358-348 A376-TP348	A403-WP348	A182-F348
	A312-TP348H	A403-WP348H	A182-F348H

1. When fittings are of welded construction, or made from welded pipe, the fitting manufacturer shall supplement the grade symbol marking with the letter "W"

Stainless Steel Pipe and Tube Stock

ASTM A312 Nominal Bore Piping (5-7 Metre Lengths)

Description (Metric & Imperial)	Size* (mm)	Mass (kg/mtr)	304L Seam-less	316L Seam-less	304L Welded	316L Welded
Schedule 10						
8-1/4"	13.72 x 1.65	0.50	✓	✓		
15-1/2"	21.34 x 2.11	1.02	✓	✓	✓	✓
20-3/4"	26.67 x 2.11	1.30	✓	✓	✓	✓
25-1"	33.40 x 2.77	2.13	✓	✓	✓	✓
32-1 1/4"	42.16 x 2.77	2.73	✓	✓	✓	✓
40-1 1/2"	48.26 x 2.77	3.16	✓	✓	✓	✓
50-2"	60.33 x 2.77	3.99	✓	✓	✓	✓
65-2 1/2"	73.03 x 3.05	5.34	✓	✓		
80-3"	88.90 x 3.05	6.56	✓	✓	✓	✓
100-4"	114.30 x 3.05	8.50	✓	✓	✓	✓
150-6"	168.28 x 3.40	14.04			✓	✓
200-8"	219.08 x 3.76	20.27			✓	✓
250-10"	273.05 x 4.19	28.21			✓	✓
300-12"	323.85 x 4.58	36.54				✓
Schedule 40						
8-1/4"	13.72 x 2.24	0.73	✓	✓		
10 3/8"	17.15 x 2.37	0.86	✓	✓		
15-1/2"	21.34 x 2.77	1.29	✓	✓	✓	✓
20-3/4"	26.67 x 2.87	1.71	✓	✓	✓	✓
25-1"	33.40 x 3.38	2.54	✓	✓	✓	✓
32-1 1/4"	42.16 x 3.56	3.44	✓	✓		
40-1 1/2"	48.26 x 3.68	4.12	✓	✓	✓	✓
50-2"	60.33 x 3.91	5.53	✓	✓	✓	✓
65-2 1/2"	73.03 x 5.16	8.77	✓	✓		
80-3"	88.90 x 5.49	11.47	✓	✓	✓	✓
100-4"	114.30 x 6.02	16.34	✓	✓	✓	✓
125-5"	141.30 x 6.55	22.13	✓	✓		
150-6"	168.28 x 7.11	28.72		✓	✓	✓
200-8"	219.08 x 8.18	43.22		✓	✓	✓
Schedule 80						
8-1/4"	13.72 x 3.02	0.81		✓		
15-1/2"	21.34 x 3.73	1.65	✓	✓		
20-3/4"	26.67 x 3.91	2.23	✓	✓		
25-1"	33.40 x 4.55	3.29	✓	✓		
32-1 1/4"	42.16 x 4.85	4.54	✓	✓		
40-1 1/2"	48.26 x 5.08	5.49	✓	✓		
50-2"	60.33 x 5.54	7.60	✓	✓		
65-2 1/2"	73.03 x 7.01	11.60		✓		
80-3"	88.90 x 7.62	15.52	✓	✓		
100-4"	114.30 x 8.56	22.70	✓	✓		
150-6"	168.28 x 10.97	43.25		✓		

*Outside diameter x Wall thickness

Also available:
Seamless tubing to ASTM A213
Welded tubing to ASTM A249
Welded pipe to ASTM A358
Tubing for Dairy, Food and Beverage use.

BS 3605 Spiral Weld Pipe

Diameter (Outer or Nominal Bore) (mm)	Wall Thickness mm								
	1.6	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
40	✓	✓							
50 - 80	✓	✓	✓	✓					
80 - 100	✓	✓	✓	✓	✓	✓	✓		
100 - 125	✓	✓	✓	✓	✓	✓	✓	✓	✓
150 - 300	✓	✓	✓	✓	✓	✓	✓	✓	✓
350 - 550				✓	✓	✓	✓	✓	✓

Standard Grades : 3CR12, 304L, 316L
Lengths : Usually 6 metres, but any lengths up to 9.25 metres can be manufactured
Ends : Plain or flanged

Stainless Steel Ornamental Tube* (6.1) Metre Lengths

Description OD x WT	Mass kg/mtr	304L welded
19.08 x 1.2	0.537	✓
19.08 x 1.6	0.700	✓
25.4 x 1.2	0.728	✓
25.4 x 1.6	0.955	✓
31.8 x 1.2	0.921	✓
31.8 x 1.6	1.212	✓
38.1 x 1.2	1.111	✓
38.1 x 1.6	1.465	✓
44.5 x 1.2	1.304	✓
44.5 x 1.6	1.722	✓
44.5 x 2.0	2.133	✓
50.8 x 1.2	1.494	✓
50.8 x 1.6	1.975	✓
63.5 x 1.6	2.485	✓

* Non Specification Tube
Normally stocked in polished condition (180 Grit); plastic sleeved.

Stainless Steel Seamless Tubing (6 Metre lengths)

Size (mm)	Mass kg/mtr	Grade 316
6.0 x 1.0	0.125	✓
8.0 x 1.0	0.175	✓
10.0 x 1.0	0.225	✓
12.0 x 1.0	0.275	✓

Stainless Steel Billet

Size (mm)	Grade		
	304L	316L	321
100 Sq	√	√	√
150 Sq	√	√	√
200 Sq	√	√	√
288 Sq	√	√	√
380 Sq	√	√	√
150 Rnd	√	√	√
200 Rnd	√	√	√
250 Rnd	√	√	√
300 Rnd	√	√	√
400 Rnd	√	√	√

Also available on enquiry: 304/304H
316
SAF 2205

ASTM A276
Stainless Steel Square Bar

Size (mm)	Grade		Theoretical Mass (kg/mtr)
	304	316	
6.35 x 6.35	√		0.32
9.53 x 9.53		√	0.73
12.7 x 12.7	√	√	1.29
19.05 x 19.05	√	√	2.90
25.4 x 25.4	√	√	5.16
38.1 x 38.1	√	√	11.61
50.8 x 50.8		√	20.65

Note:
1. Hot rolled, annealed and pickled condition
2. Supplied in 3-6 metre random lengths

ASTM A276
Stainless Steel Equal Angle

Size (mm)	Grade		Theoretical Mass (kg/mtr)
	304	316	
25 x 25 x 3	√	√	1.18
40 x 40 x 3	√	√	1.88
50 x 50 x 3	√	√	2.36
25 x 25 x 4.5	√	√	1.77
30 x 30 x 4.5	√	√	2.12
40 x 40 x 4.5	√	√	2.83
50 x 50 x 4.5	√	√	3.53
25 x 25 x 6	√	√	2.36
40 x 40 x 6	√	√	3.77
50 x 50 x 6	√	√	4.71
65 x 65 x 6	√	√	6.12
75 x 75 x 6	√	√	7.07
50 x 50 x 10		√	7.85
75 x 75 x 10		√	11.78

Note:
1. Hot rolled, annealed and pickled condition
2. Supplied in 3-6 metre random lengths

ASTM A276
Stainless Steel Flat Bar

Size (mm)	Grade		Theoretical Mass (kg/mtr)
	304	316	
25 x 3	√	√	0.60
32 x 3	√	√	0.77
40 x 3	√		0.95
50 x 3	√	√	1.20
25 x 4.5	√	√	0.90
32 x 4.5		√	1.15
40 x 4.5	√	√	1.44
50 x 4.5	√	√	1.80
25 x 6	√	√	1.20
32 x 6	√	√	1.54
40 x 6	√	√	1.92
50 x 6	√	√	2.40
65 x 6	√	√	3.12
75 x 6	√	√	3.60
25 x 10	√	√	2.00
40 x 10	√	√	3.20
50 x 10	√	√	4.00
56 x 10	√		4.48
65 x 10		√	5.20
75 x 10	√		5.93
25 x 12	√		2.37
40 x 12	√		3.79
50 x 12	√	√	4.080
75 x 12	√	√	7.20

Note:
1. Hot rolled, annealed and pickled condition
2. Supplied in 3-6 metre random lengths

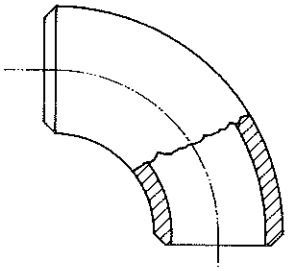
Pipe Fittings

Technical

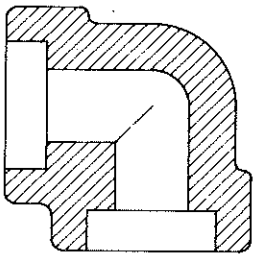
Types of Fittings

A pipe fitting is defined as a part used in a pipe system to change direction of flow or change function, and which is mechanically joined to the system.

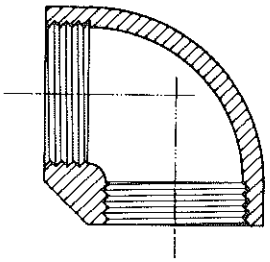
The common methods for joining the fittings in the piping system are:



1. **Butt Weld.** The ends of the fittings and the pipe are abutted and joined by welding. Ends may be chamfered - weld prepared.



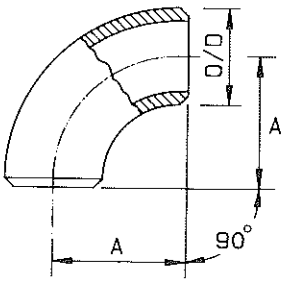
2. **Socket Weld.** The fitting is designed with a socket to receive the end of the pipe and the two are attached by welding. Normally used for high pressure systems.



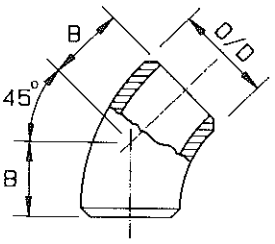
3. **Thread (Screw) Systems.** The fitting and the pipe are machined with the same threads and joined mechanically in this way.

Some of the more usual fittings are shown in the following figures. Please enquire for dimensional details, the critical elements of which are indicated.
For long radius elbows,
Dimension A = 1.5 x nominal pipe size.

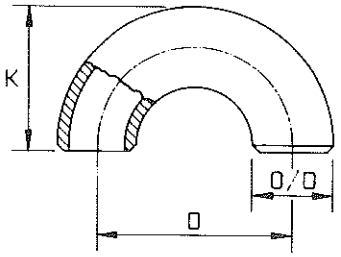
90° Elbows



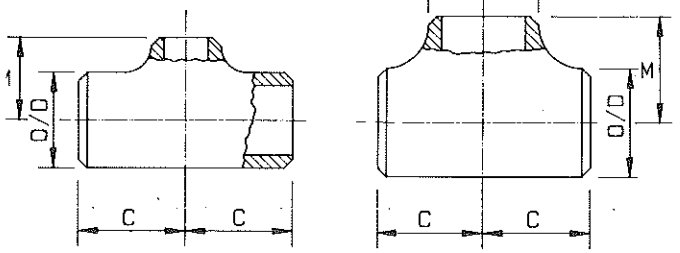
45° Elbows



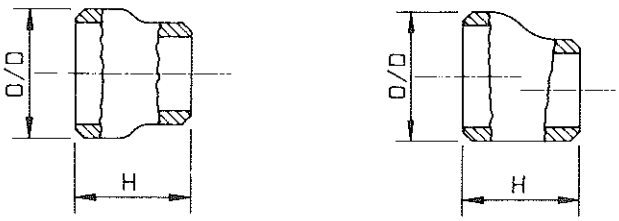
180° Return Bends



Equal and Reducing Tees

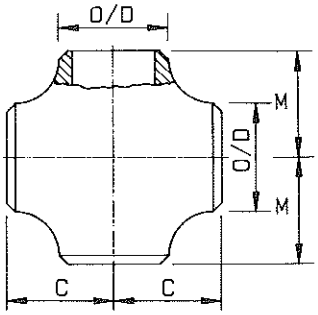


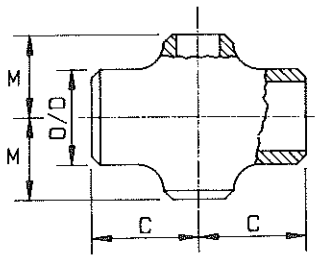
Concentric and Eccentric Reducers



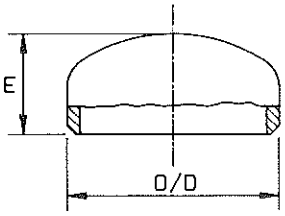
Technical

Equal and Reducing Crosses

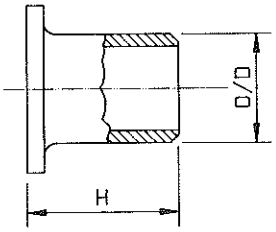




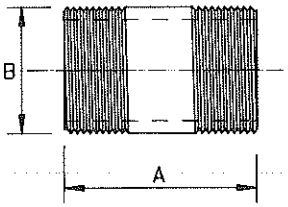
Caps Ends



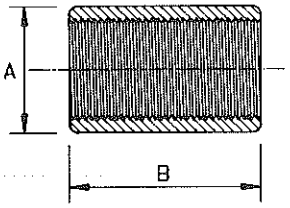
Lap Joint Stub



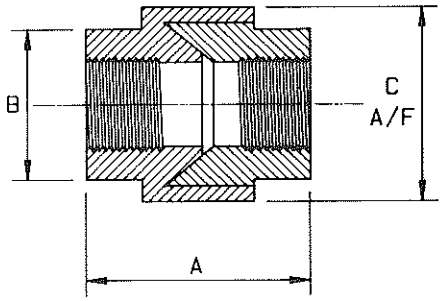
Barrel Nipples



Sockets



Unions



Technical data on fittings available upon enquiry.

Standard and Specifications

As with pipe and tube, fittings may be supplied to a range of national and international standards.

The more common standards used for pipe fittings in South Africa are:

ASTM A182	-	Forged and rolled alloy steel pipe flanges, forged fittings and valves and parts for high temperature service.
ASTM A403	-	Wrought austenitic stainless steel piping fittings.
ANSI B16-9	-	Butt Weld Fittings
ANSI B16-11	-	Forged steel fittings, socket welding and threading.
BS 3799	-	Steel pipe fittings, screwed and socket welding for the petroleum industry.
MSS-SP43	-	Manufacturing standard covering stainless steel butt welding fittings.

Stainless Steel Fitting Stock

ASTM A403 Butt Weld Fittings

Description (Metric & Imperial)		90° L.R. Elbows		Tees	
		304L	316L	304L	316L
Schedule 10	15-1/2"	√	√	√	√
	20-3/4"	√	√	√	√
	25-1"	√	√	√	√
	32-1 1/4"	√	√		
	40-1 1/2"	√	√	√	√
	50-2"	√	√	√	√
	65-2 1/2"	√	√	√	√
	80-3"	√	√	√	√
	100-4"	√	√	√	√
	150-6"	√	√	√	√
	200-8"	√	√		√
	250-10"	√	√		
	300-12"		√		
Schedule 40	15-1/2"	√	√	√	√
	20-3/4"	√	√	√	√
	25-1"	√	√	√	√
	40-1 1/2"	√	√	√	√
	50-2"	√	√	√	√
	65-2 1/2"	√	√		
	80-3"	√	√	√	√
	100-4"	√	√	√	√
	150-6"	√	√	√	√
	200-8"	√	√	√	√
Schedule 80	15-1/2"	√	√		
	20-3/4"	√	√		
	25-1"	√	√		
	40-1 1/2"	√	√		
	50-2"	√	√		
	80-3"	√	√		
	100-4"	√	√		

ASTM A403 Butt Weld Fittings

Description (Metric & Imperial)	Concentric Reducers			
	Schedule 10		Schedule 40	
	304L	316L	304L	316L
20 x 15-3/4" x 1/2"	√	√		
20 x 15-1" x 1/2"	√	√	√	√
25 x 20-1" x 3/4"				√
40 x 20-1 1/2" x 3/4"	√	√	√	
40 x 25-1 1/2" x 1"	√	√	√	√
50 x 25-2" x 1"	√	√	√	√
50 x 40-2" x 1 1/2"	√	√	√	√
65 x 50-2 1/2" x 2"		√		
80 x 50-3" x 2"	√	√	√	√
100 x 50-4" x 2"	√	√	√	√
100 x 80-4" x 3"	√	√	√	√
150 x 80-6" x 3"		√	√	√
150 x 100-6" x 4"	√	√	√	√
200 x 150-8" x 6"		√	√	

ANSI 16.11 / BS3799 ASTM A182
316L Socket Weld Forged Fittings - 3000 lbs

Description (Metric and Imperial)	90° Elbow	45° Elbow	Equal Tees	Bank Tees	Full Coupling	Half Coupling	Unions
15-1/2"	√	√	√	√	√	√	√
20-3/4"	√	√	√	√	√	√	√
25-1"	√	√	√	√	√	√	√
40-1 1/2"	√	√	√	√	√	√	√
50-2"	√	√	√	√	√	√	√

ANSI 16.3
316BSP Screwed Fittings - 150lb

Description (Imperial and Metric)	Nipples	Socket	Tees	90°C Elbow	Unions	Plugs
6-1/8"	√					
8-1/4"	√	√	√	√	√	√
10-3/8"	√	√	√	√	√	√
15-1/2"	√	√	√	√	√	√
20-3/4"	√	√	√	√	√	√
25-1"	√	√	√	√	√	√
32-1 1/4"	√	√	√	√	√	√
40-1 1/2"	√	√	√	√	√	√
50-2"	√	√	√	√	√	√
65-2 1/2"				√	√	√
80-3"	√	√	√	√	√	√

ANSI B 16.3
316 BSP Screwed Fittings - 150 lb

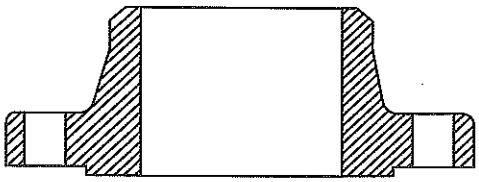
Description (Metric and Imperial)	Reducing Bushes	Reducing Sockets
8 x 6-1/4" x 1/8"	√	√
10 x 8-3/8" x 1/4"	√	√
15 x 8-1/2" x 1/4"	√	√
15 x 10-1/2" x 3/8"	√	√
20 x 8-3/4" x 1/4"	√	√
20 x 10-3/4" x 3/8"	√	√
20 x 15-3/4" x 1/2"	√	√
25 x 8-1" x 1/4"	√	
25 x 10-1" x 3/8"	√	√
25 x 15-1" x 1/2"	√	√
25 x 20-1" x 3/4"	√	√
32 x 25-1 1/4" x 1"	√	
40 x 25-1 1/2" x 1"	√	√
50 x 25-2" x 1"	√	
50 x 40-2" x 1 1/2"	√	
80 x 50-3" x 1"	√	

Flanges

Types

The following are some of the common flanges types used

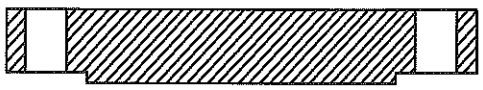
Weld Neck Flange



Slip-on Flange

Socket weld Flange

Blind (blank) Flange



Threaded Flange

Materials

Standard materials include F304L, F316L, F321, flanges in alloy such as 3CR12, SAF2205, 904L, etc. can also be supplied. Other stainless steels covered by ASTM A 182 (forgings) and ASTM A 240 (plate) can be supplied subject to availability.

Specifications

Some of the common specifications to which stainless steel flanges can be manufactured are:

ANSI B 16.5	-	Rating (lb) 150, 300, 400, 600, 900, 1500, 2500.
BS4504	-	Rating (bar) 10, 16, 25, 40, 64, 100, 160.
DIN 2631/32	-	Rating PN6, PN10, PN16,
33/34/	-	PN25, PN40, PN64, PN100,
35/36	-	PN160.
37		
DIN 2573/2576		
DIN 2527		
SABS 1123	-	Rating (kPa) 250, 600, 1000, 1600, 2500, 4000, 6400.

For large diameter flanges the specifications used are API 605 and MSS SP-44

For additional information on flanges, dimensions, pressure ratings, specifications, etc, please contact the VRN Technical staff.

Ordering Information

When ordering please state:

- applicable standards
- material
- pressure rating
- pipe size schedule
- face design (flate face; raised face; etc.)
- quantity

ALUMINIUM

General Information

Aluminium is a remarkable metal not for one particular quality, but for a combination of qualities that make it unlike any other material available to man.

Corrosion Resistance. Aluminium resists attacking elements in the atmosphere, water (including salt water), oils and many chemicals.

Light Weight. Aluminium weighs only about 2.71g per cubic cm which is approximately one-third the weight of the same amount of steel, copper or brass.

Strength. Some aluminium alloys actually exceed structural steel in strength.

Workability. Aluminium responds easily to every type of metal-working, from primitive tools and sheer muscle power to high-speed, power-driven machinery.

Reflection. Aluminium is highly reflective to radiant energy, visible light, radiant heat, and radio and radar waves.

High Electrical Conductivity. For the same mass, aluminium will conduct approximately 60% more electric current than copper.

High Thermal Conductivity. The high thermal conductivity of aluminium (about three times that of iron) is important in applications that involve either heating or cooling - for example, cooking utensils, refrigerator evaporators, automotive engine components and heat exchangers.

Non-magnetic. This is an important property in the electrical and electronics industries, and means that aluminium is easily recyclable at only 5% of the energy it takes to make it from bauxite ore.

Non-toxicity makes aluminium entirely safe for use with foods and beverages.

Attractive Appearance. Aluminium looks good in its natural finish, which can be soft and lustrous or bright and shiny; and it can take virtually any colour or texture.

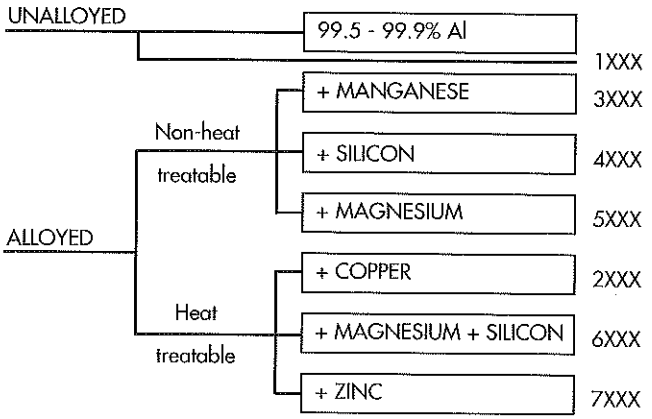
Add up all the above qualities, and you find that aluminium has the greatest VERSATILITY of any metal in use. It can be formed and fabricated easily for any industrial use, and will accept a variety of decorative surface treatments.

The aluminium alloys stocked by Jackson Metals cover a wide range of potential applications. This brochure sets out the more important properties and forms in which they are available. The brochure also highlights certain factors to be taken into consideration when fabrication and using aluminium. Queries on alloys not mentioned here, may be directed to any branch of VRN.

Alloy Systems and Tempers

Alloys

The first of the four digits in the designation indicates the alloy group in terms of the major alloying element.



In high-purify form aluminium is soft and ductile. To increase its strength, elements can be added to produce various alloys.

Non-heat-treatable alloys

The non-heat-treatable alloys are those in which the mechanical properties are determined by the amount of cold work introduced (e.g. by rolling, drawing etc.) after the last annealing operation. Usually the 1000, 3000, 4000 and 5000 alloys are non-heat-treatable. The 4000 series is used for welding filler materials. The properties obtained by cold work are destroyed by subsequent heating and cannot be restored except by additional cold work.

Heat-treatable alloys

The heat-treatable alloys are those in which the mechanical properties may be improved by heat-treatment. In contrast to the non-heat-treatable alloys the increased strength is obtained with little sacrifice of ductility. Heat-treatable alloys have the further advantage that they can be reheat-treated after annealing to restore their original properties.

Temper Designation System

Hulett Aluminium has phased in a new temper designation system similar to the ISO 2107 alternative temper designation system which is widely recognised internationally and closely approximates that of the Aluminium Association. The new system which is an extension of the existing one defines the sequence of basic treatments used to achieve the various tempers. The temper designation follows the four digit Aluminium alloy designation, the two being seperated by a hyphen. Basic temper designations consist of letters whereas subdivisions

Temper Designations... continued

of these basic tempers are indicated by one or more digits following the letter.

Basic Temper Designations

F **As fabricated.** Applies to the products of shaping processes in which no special control over thermal conditions or strain-hardening is employed. For wrought products, there are no specified requirements for mechanical properties.

O **Annealed.** Applies to wrought products which are annealed to obtain the lowest strength condition.

H **Strain-hardened.** (wrought products only). Applies to products subjected to the application of cold work after annealing (or hot forming), or to a combination of cold work and partial annealing or stabilising in order to secure the specified mechanical properties. The H is always followed by two (or more) digits.

T **Thermally treated** to produce stable tempers other than F, O or H. Applies to products which are thermally treated, with or without supplementary strain-hardening, to produce stable tempers. The T is always followed by one (or more) digits indicating the specific sequence of treatments.

Subdivisions of H temper : strain-hardened

The first digit following the H indicates the specific combination of basic operations viz.

H1x **Strain-hardened only.** Applies to products which are strain-hardened to obtain the desired strength without supplementary thermal treatment. The number following this designation indicates the degree of strain-hardening.

H2x **Strain-hardened and partially annealed.** Applies to products which are strain-hardened more than the desired final amount and then reduced in strength to the desired level by partial annealing. The number following this designation indicates the degree of strain-hardening remaining after the partial anneal.

H3x **Strain-hardened and stabilised.** Applies to products which are strain hardened and whose mechanical properties are stabilised by a low temperature thermal treatment which results in slightly lower tensile strength and improved ductility. (Only applicable to those alloys which, unless stabilised, gradually age-soften at room temperature.) The number following this designation indicates the degree of strain-hardening remaining after the stabilisation treatment.

H4x **Strain-hardened and stoved.** Applies to products which are strain-hardened and whose mechanical properties are modified by subsequent thermal treatment during paint stoving operations. The number following this designation indicates the degree of strain-hardening remaining after the stoving process.

The digit (2, 4, 6, 8 or 9) following the designations H1, H2, H3 & H4 indicates the degree of strain-hardening as follows:

Hx2 Tensile strength about midway between 0 & Hx4 temper.

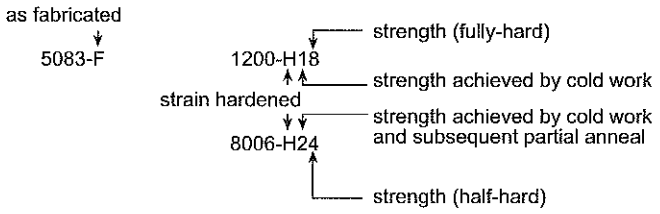
Hx4 Tensile strength about midway between 0 & Hx8 temper.

Hx6 Tensile strength about midway between Hx4 & Hx8 temper.

Hx8 Full hard temper.

Hx9 Tensile strength in excess of full hard temper.

Examples:



Subdivisions of T temper : Thermally treated.

The digit following the T indicates the specific sequences of basic treatments viz.

T3 **Solution heat-treated, cold worked, and naturally aged to a substantially stable condition.** Applies to products which are cold worked by a controlled amount to improve their strength after solution heat-treatment, or in which the effect of cold work in flattening or straightening is recognised in mechanical property limits.

T4 **Solution heat-treated and naturally aged to a substantially stable condition.** Applies to products which are not cold worked after solution heat-treatment, or in which the effect of cold work in flattening or straightening may not be recognised in mechanical property limits.

T5 **Cooled from an elevated temperature shaping process and then artificially aged.** Applies to products which are not cold worked after cooling from an elevated temperature shaping process, or in which the effect of cold work in flattening or straightening may not be recognised in mechanical property limits.

T6 **Solution heat-treated and then artificially aged.** Applies to products which are not worked after solution heat-treatment, or in which the effect of cold work in flattening or straightening may not be recognised in mechanical property limits.

T8 **Solution heat-treated, cold worked and then artificially aged.** Applies to products which are cold worked to improve strength, or in which the effect of cold work in flattening or straightening is recognised in mechanical property limits.

Examples:

annealed, soft → 6082-O

6063-T6 ← thermally treated → solution heat-treated and artificially aged

7075-T8 ← solution heat-treated, cold worked an artificially aged

Temper Designation Cross-Reference

NEW		OLD
F	As fabricated	M
O	Annealed, soft	O
H	Strain-hardened, non-heat-treatable alloy	H
H1x	Strain-hardened only	No Equivalent
H2x	Strain-hardened & partially annealed	No Equivalent
H3x	Strain-hardened & stabilised	No Equivalent
H4x	Strain-hardened & stoved	No Equivalent
H12,H22,H32,H42	Quarter hard	H2
H14,H24,H34,H44	Half hard	H4
H16,H26,H36,H46	Three-quarters hard	H6
H18,H28,H38,H48	Fully-hard	H8
H19	Temper in excess of fully-hard	No Equivalent
T	Thermally treated, heat-treatable alloy	T
T3	Solution heat-treated, cold worked & naturally aged	TD
T4	Solution heat-treated & naturally aged	TB
T5	Cooled from an elevated temperature process & artificially aged	TE
T6	Solution heat-treated and artificially aged	TF
T8	Solution heat-treated, coldl worked and artificially aged	TH

Several temper variants of the basic system are available subject to enquiry. Any queries concerning Aluminium alloys and their temper designations should be directed to your nearest Hulett Aluminium Sales Office or to our Head Office.

Technical Grade

Some applications require evidence of the conformance of aluminium to given specifications. This can be obtained by specifying 'Technical Grade', and certification covering composition properties and traceability will be supplied.

Note: Much of the stockholding is not Technical Grade because common usage does not require it.

Fabrication and Care of Aluminium

Note: More comprehensive information on the use of aluminium can be obtained from VRN technical staff.

Bending Data

Minimum Recommended Radii for 90° Cold Bends in Aluminium sheet

The radii given below are based on normal workshop practice. Minimum possible radii should be determined by forming a sample of the sheet or plate in actual use.

Alloy Temper		Thickness - millimetres						
		0.5	1.2	2.5	3.0	4.0	5.0	6.0
		Bend radii in terms of t (thickness) - 0 indicates zero radius						
1200	O	0	0	0	0	0	0	0
	M				0	½t	1t	1t
	H4	0	0	0	0	½t	1t	1t
	H6	0	½t	1t	1½t	1½t	1½t	2½t
	H8	1t	2t	2t	3t	3t	4t	4t
5251	O	0	0	½t				
	M				1t	1½t	2t	2½t
	H6	0	1t	1½t				
	H8	2t	4t	4t				
5254	O	0	0	½t	½t	1t	1½t	1½t
	M				1½t	2t	2½t	3t
	H2	0	1t	1t				
	H4	1t	2t	2t				
5083	O	0	0	1t	1t	1t	1½t	2t
	M				2t	3t	4t	6t
	H2	1t	1½t	2t				
	H4	2t	3t	4t				

The tendency for metal to spring back after bending must be considered in tool design. As this is due to the elastic deformation that occurs in addition to the normal plastic deformation of the material, it is most marked in hard material of high yield strength, but negligible with dead soft tempers. It is also increases with decreasing metal thickness.

Punching and shearing are best carried out on materials in the hard condition if this is possible, owing to the fact that soft material tends to drag. Alloys in the intermediate or hard-rolled temper, give cleaner edges and are not so liable to distortion and bending under the punch.

Welding

Most aluminium can be welded easily provided care is taken of a few factors.

Aluminium always has a tough corrosion resistant film on its surface due to oxidation. This oxide melts at a higher temperature than aluminium and must be removed before welding. Either chemical, mechanical or electrical means may be used. The oxide must be prevented from reforming after cleaning.

Aluminium has a high thermal conductivity of about one-half that of copper and four times that of mild steel. Heat therefore needs to be applied four times as fast for steel to raise the temperature locally by the same amount.

Aluminium has a coefficient of linear expansion of about twice that of steel. This must be recognised when the material is constrained by fixtures.

Aluminium and its alloys have low melting points ranging from 500 - 600°C. As the temperature approaches the melting point, there is no change in colour as occurs in copper or steel. Care therefore needs to be taken to avoid melting of too large an area of the aluminium.

The range of availability filler wires for TIG and MIG welding consists essentially of pure aluminium, Al-Mg and Al-Si alloys. It is possible to cope with situations using one of these compositions.

Base Metal	Preferred Filler Metal
Pure aluminium	Equivalent grade of pure aluminium or Al-5% Si when corrosion resistance is not the critical factor.
Al-Mg	Al-5% Mg (e.g. 5356, 5183, 5556)
Al-Mg-Si	Al-5% Mg or Al-5% Si
Al-Mg-Zn	Al-5% Mg

The table below details the relationship between base and filler alloys for the full range of alloys produced in South Africa.

Recommended Filler Material

Base metal to base metal	1350 1070A 3103 1145 1200 3003	3105 3004	5251 5052	5182 5083	5454	6101A 6070 6261 6060 6463 6005 6063 6082	7017 7020
1350 1070A 3103 1145 1200 3003	1100 (b)	4043 (d)	4043 (d)	5356 (b) (d)	4043 (d)	4043	5356 (b) (d)
3105 3004		4043 (d)	4043 (d)	5356 (d)	5356 (a)	4043 (d)	5356 (b) (d)
5251 5052			(a) (b)	5356 (d)	5356 (a)	5356 (a) (b)	5356 (a)
5182 5083				5183 (d)	5356 (d)	5356 (d)	5183 (d)
5454					5554 (b) (d)	5356 (a) (b)	5356 (a)
6101A 6070 6261 6060 6463 6005 6063 6082						4043 (a)	5356 (a) (b)
7017 7020							5356 (a)

1. The filler metal shown for each combination of base metals is that most commonly used. However, the specific filler metal depends upon usage and type of joint and, in a number of cases, acceptable alternates are recommended (footnotes a to d)
2. Filler metals conform to requirements of AWS Specification A5. 10-80.
3. Exposure to specific chemicals or a sustained high temperature (over 65°C) may limit the choice of filler metals. Filler alloys 5183, 5356, 5556 should not be used in sustained elevated-temperature service.
   (a) 5183, 5356, 5554, 5556 and 5654 may be used. In some cases they provide (1) improved colour match after anodising treatment, (2) higher weld ductility and (3) higher weld strength. 5554 is suitable for elevated-temperature service. Castings welded with these filler metals should not be subject to post-weld artificial ageing.
   (b) 4043 may be used for some applications.
   (c) Filler metal with the same analysis as the base metal is sometimes used.
   (d) 5183, 5356 or 5556 may be used.

Storage and Care of Aluminium

Time and money can be lost unless the manufacturer and user adopt a few simple procedures to protect the aluminium finish during processing, handling, storage and erection.

Inspection of Material

Upon receiving aluminium components any paper wrapper should be removed as soon as practicable. If the aluminium is protected by a strippable coat this should be left in place. It should, however, be inspected to ensure that there are no breaks or gaps.

Unloading and handling

Aluminium commodities are supplied as a finished or semi-finished product. In many cases they have a highly polished surface: therefore, they need care in handling. The following simple precautions should be observed:

- ➢ Do not drag or throw parts to the ground, rather lift and carry.
- ➢ Avoid parts scraping each other or against other hard or sharp surfaces
- ➢ When hoisting use slings to evenly distribute lifting stress; this will avoid distortion
- ➢ Do not permit sling hooks, wires or other handling equipment to damage the aluminium surface

Storage on site

To maintain the best possible surface condition over long periods:

- ➢ Unpack as soon as possible and within seven days of delivery,
- ➢ oil the surface, and
- ➢ store
  - in a vertical position to allow unrestricted circulation of air over all surfaces (take care not to damage edges),
  - in an enclosed area,
  - away from direct air draughts,
  - under conditions of controlled humidity and temperature,
  - with filtration to eliminate chemically contaminated and dust laden air,
  - away from contact with other material.

Care in working procedures

Stubborn stains to aluminium surfaces are often caused by splashing, spattering and run-down of cement, mortar, etc.

To avoid these it is recommended that:

- ➢ aluminium surfaces are protected through the application of a clear lacquer or oil prior to delivery on site.
- ➢ aluminium installation work be delayed as late as possible
- ➢ all accidental splashing of mortar, plaster, concrete, paint or other wet preparations be wiped from the aluminium surfaces before they dry (Particular care should be taken where acid solutions are used to clean brick-work and masonry)
- ➢ if the metal or its protective coating is spattered with acid, rinse all surfaces and hose out cracks and crevices thoroughly with water

Note

When removing spatters of mortar and plaster these should be chipped off with a wooden or plastic scraper. Use of metal tools may damage the finished aluminium surface.

International Alloy Designations and Equivalents

Aluminium Association (A.A.)	Obsolete System	British Standard	Germany	France	Italy
1050A*	1S	1B	Al99.5	A5	P-AP5 UNI4507
1080A*	–	1A	Al99.8	A8	P-AP8 UNI 4509
1200	2S	1C	Al99	A4	P-APO UNI 3567
3103*	3S	N3	AlMn	A-M1	–
4043*	33S	N21	AlSi5	A-S5	–
4047*	–	N2	AlSi12	A-S12	P-AS12 GCN UN 3572
5056A*	A56S	N6	AlMg5	A-G5MC	P-AG5 UNI 3576
5083	D54S	N8	AlMg4.5 Mn	A-G4.5MC	–
5154A*	54S	N5	AlMg3	A-G3C	P-AG3.5 UNI 3575
5183*	–	–	AlMg 4.5Mn	A-G5MC	–
5251	M57S	N4	AlMg2Mn0.3	A-G2M	–
5356*	–	–	AlMg5	A-G5MC	–
5454	B53S	N51	AlMg2.7Mn	A-G2.5MC	–
5554*	C53S	N52	AlMg3	A-G3	–
5556A*	C56S	N61	AlMg5	A-G5MC	–
6061	65S	H20	–	A-GSUC	AG1SC
6261	D65S	–	–	–	UNI6170
6063	50S	H9	AlMgSi0.5	A-G0.6	P-AGS UNI 3569
6351	B51S	H30	AlMgSi1	A-SGM0.7	P-AS1G UNI 3571

*Welding filler alloys

Data Sheet

1200 (Non Heat-Treatable) Commercial-Purity Aluminium

Chemical Composition Limits (in %) Aluminium 99.00 minimum

					Other elements	
Cu	Si + Fe	Mn	Zn	Ti	Each	Total
0.05	1.0	0.05	0.1	0.05	0.05	0.15

Outstanding Characteristics:

Very good corrosion resistance and workability.
Very ductile in annealed condition. Anodises well.

Standard Commodities:

Plate, sheet, coil, treadplate.

Typical Uses:

Holloware, equipment and containers for chemical, food and brewing industries; decorative assemblies in architecture and transport, panelling.

Typical Physical Properties

Density	2.71	g/cm^3
Modulus of Elasticity	70	GPa
Modulus of Rigidity	26.5	GPa
Melting Range	640-660	°C
Specific heat between 0-100°C (273-373 K)	1.01	J/g°C
Coefficient of linear expansion between 20-200°C (293-473 K)	25×10^{-6}	/°C
Thermal Conductivity at 100°C (373K)	220	W/m°C
Resistivity at 20°C (293 K)	0.030×10^{-6}	Ωm

Other Characteristics

Corrosion Resistance	: Very Good
Weldability	: Excellent
Formability	: Excellent
Anodizing	: Very Good
Brazeability	: Excellent

Typical Mechanical Properties

Temper	0.2% Proof Stress MPa	Ultimate Tensile Strength MPa	% Elongation in 50 mm
M	50	90	
0	35	85	33
H4	105	125	8

Data Sheet

3003 (Non Heat-Treatable) Al-Mn Wrought Alloy

Chemical Composition Limits (in %)

Cu	Si	Fe	Mn	Zn	Other elements Each	Other elements Total
0.05 0.2	0.6	0.7	1.0 1.5	0.1	0.05	0.15

Outstanding Characteristics:

Compared with 3103, improved resistance against pitting corrosion.
Easily shaped by pressing and forming. Very good finishing properties.

Standard Commodities:

Sheet, strip circles.

Typical Uses:

Domestic appliances. Car trim applications. Foil.

Typical Physical Properties

Density	2.73	g/cm^3
Modulus of Elasticity	70	GPa
Modulus of Rigidity	26.5	GPa
Melting Range	643-654	°C
Specific heat between 0-100°C (273-373 K)	0.92	J/g°K
Coefficient of linear expansion between 20-100°C (293-373 K)	23×10^{-6}	/K
Thermal Conductivity at 25°C (298K)	151-188	W/mK
Resistivity at 20°C (293 K)	0.034×10^{-6}	Ωm

Other Characteristics

Corrosion Resistance	: Very Good
Weldability	: Very Good
Formability	: Very Good
Anodizing	: Very Good
Brazeability	: Excellent

Mechanical Properties

Commodity and Temper	Gauge mm	0.2% Proof Stress MPa	Ult. Tensile Strength MPa	Elongation A_5 %	Brinell Hardness HB	Ultimate Shear Strength MPa
Extrusions						
F			90	(15)*		
O			90			
Sheet						
F	0.2-12.5	35-245	95-250			
O	0.2- 6.0	35- 70	95-130	25*		
H12	0.1- 6.0	85-130	120-160	6-8*		
H18	0.2- 6.0	165- 225	185-230	4*		
Foil						
O	0.08-0.15	35	95-130			
H113	0.08-0.15	45	- -140			

*50mm gauge length; Sheet: thickness over 1.3-2.6mm

Note: Corresponding H2. tempers also available subject to agreement of properties between client and supplier.

Annealing

Temperature °C	Time
400±3	Until all parts have attained the annealing temperature.

Data Sheet

3004 (Non-Heat-Treatable) Al-Mn-Mg

Chemical Composition Limits (in %)

						Other elements	
Mn	Mg	Fe	Si	Cu	Zn	Each	Total
1.0-1.5	0.8-1.3	0.7	0.30	0.05	0.25	0.05	0.15

Outstanding Characteristics:

Stronger than 1200 alloys.

Standard Commodities:

Extrusion ingot. Plate, sheet, strip, circles.

Typical Uses:

Containers for chemical, food and brewing industries, roofing, decorative assemblies in architecture and transport.

Typical Physical Properties

Density	2.72	g/cm^3
Modulus of Elasticity	69	GPa
Thermal Conductivity at 25°C (298K)	1.64	W/cm - K
Coefficient of linear expansion between 20-100°C (293-373 K)	24×10^{-6}	/K
Specific electrical resistance at 20°C (293 K)	0.041	Ωm

Other Characteristics

Corrosion Resistance : Very Good
Anodizing : Good
Weldability : Excellent
Formability : Very Good

Typical Mechanical Properties

Commodity and Temper	Gauge mm	0.2% Proof Stress N/mm^2	Ult. Tensile Strength N/mm^2	Elongation A_5 %	Brinell Hardness HB
Sheet, plate and coils					
O	0.5 - 2.5		152 - 201	18	45
	> 2.5 - 6		152 - 201	16	45
	> 6 - 12		152 - 201	16	45
	> 12 - 25		152 - 201	16	45
H14	0.5 - 2.5	176	215 - 255	4	63
	> 2.5 - 6	176	215 - 255	4	63
H24	0.5 - 2.5	166	215 - 255	6	63
	> 2.5 - 6	166	215 - 255	6	63
H18	0.5 - 2.5	206	255	3	77
H38	0.5 - 2.5	196	255	3.5	77

Data Sheet

5083 (Non Heat-Treatable) Al-Mg

Chemical Composition Limits (in %)

								Other elements	
Cu	Mg	Si	Fe	Mn	Zn	Ti	Cr	Each	Total
0.1	4.0	0.4	0.4	0.4	0.25	0.15	0.05	0.05	0.15
	4.9			1.0			0.25		

Outstanding Characteristics:

High strength after welding.
Very resistant to sea water and industrial atmosphere.

Standard Commodities:

Plate

Typical Uses:

Shipbuilding, car bodies, railway waggons
Recommended for pressure vessels and low temperature applications.

Typical Physical Properties

Density	2.65	g/cm^3
Modulus of Elasticity	72	GPa
Modulus of Rigidity	27	GPa
Melting Range	570-640	°C
Specific heat between 0-100°C (273-373 K)	0.97	J/g°C
Coefficient of linear expansion between 20-200°C (293-473 K)	25×10^{-6}	/°C
Thermal Conductivity at 25°C (298K)	121-126	W/m°C
Resistivity at 20°C (293 K)	0.058×10^{-6}	Ωm

Other Characteristics

Corrosion Resistance	: Excellent
Weldability	: Good
Formability	: Fair
Anodizing	: Fair
Brazeability	: Non recommended

Typical Mechanical Properties

Temper	0.2% Proof Stress MPa	Ultimate Tensile Strength MPa	% Elongation in 50 mm
H2	250	340	15

Data Sheet

5182 (Non Heat-Treatable) Al-Mg

Chemical Composition Limits (in %)

								Other elements	
Cu	Mg	Si	Fe	Mn	Zn	Ti	Cr	Each	Total
0.15	4.0	0.2	0.35	0.2	0.25	0.1	0.1	0.05	0.15
	5.0			0.5					

Outstanding Characteristics:

Good combination of formability and strength

Standard Commodities:

Sheet ingot; sheet

Typical Uses:

Car bodies. Beverage can tops.

Typical Physical Properties

Density	2.65	g/cm^3
Modulus of Elasticity	71	GPa
Modulus of Rigidity	27	GPa
Melting Range	575-640	°C
Coefficient of linear expansion between 20-200°C (293-373 K)	25 x 10^{-6}	/K
Thermal Conductivity at 25°C (298K)	121	W/mK
Resistivity at 20°C (293 K)	0.056 x 10^{-6}	Ωm

Other Characteristics

Corrosion Resistance	: Excellent
Weldability	: Good
Formability	: Very Good
Anodizing	: Excellent
Brazeability	: Non recommended

Mechanical Properties

Commodity and temper	Gauge mm	0.2% Proof Stress MPa	Ultimate Tensile Strength MPa	Elongation A_{50} %
Sheet				
O	0.6-3.2	110	255-324	18*
H18	0.3-0.4	355-400	385-425	
H22	0.8-3.5	220-280	290	10*

* Sheet thickness over 1.3mm

Annealing

Temperature °C	Time h
345	Until all parts have attained the annealing temperature

Data Sheet

5251 (Non Heat-Treatable) Al-Mg

Chemical Composition Limits (in %)

								Other elements	
Cu	Mg	Si	Fe	Mn	Zn	Ti	Cr	Each	Total
0.15	1.7	0.4	0.5	0.1	0.15	0.15	0.15	0.05	0.15
	2.4			0.5					

Outstanding Characteristics:

Universal work hardening alloy of medium strength, very good formability and corrosion resistance, good endurance properties.

Standard Commodities:

Plate, sheet.

Typical Uses:

Panelling and structures exposed to marine atmospheres; pressings; certain aircraft parts. Road vehicles body panels. Containers.

Typical Physical Properties

Density	2.69	g/cm^3
Modulus of Elasticity	70	GPa
Modulus of Rigidity	26.5	GPa
Melting Range	625-650	°C
Specific heat between 0-100°C (283-373 K)	0.92	J/g°C
Coefficient of linear expansion between 20-200°C (293-473 K)	25×10^{-6}	/°C
Thermal Conductivity at 100°C (373K)	134	W/m°C
Resistivity at 20°C (293 K)	0.044×10^{-6}	Ωm

Other Characteristics

Corrosion Resistance	: Excellent
Weldability	: Very Good
Formability	: Very Good
Machinability	: Fair
Anodizing	: Excellent
Brazeability	: Poor

Typical Mechanical Properties

Temper	0.2% Proof Stress MPa	Ultimate Tensile Strength MPa	% Elongation in 50 mm
H3	180	210	10
H6	200	240	7

Data Sheet

5454 (Non Heat-Treatable) Al-Mg

Chemical Composition Limits (in %)

								Other elements	
Cu	Mg	Si	Fe	Mn	Zn	Ti	Cr	Each	Total
0.1	2.4	0.25	0.4	0.5	0.25	0.2	0.05	0.05	0.15
	3.0			1.0			0.2		

Outstanding Characteristics:

Excellent corrosion resistance and surface finishing properties.

Standard Commodities:

Plate, treadplate

Typical Uses:

Pressure vessels operating at elevated temperatures.
Road tankers.

Typical Physical Properties

Density	2.67	g/cm^3
Modulus of Elasticity	70	GPa
Modulus of Rigidity	26.5	GPa
Melting Range	600-620	°C
Specific heat between 0-100°C (273-373 K)	0.97	J/g°C
Coefficient of linear expansion between 20-200°C (293-473 K)	25×10^{-6}	/°C
Thermal Conductivity at 100°C (373K)	134	W/m°C
Resistivity at 20°C (293 K)	0.056×10^{-6}	Ωm

Other Characteristics

Corrosion Resistance	: Excellent
Weldability	: Very Good
Formability	: Good
Machinability	: Fair
Anodizing	: Excellent

Typical Mechanical Properties

Temper	0.2% Proof Stress MPa	Ultimate Tensile Strength MPa	% Elongation in 50 mm
H2	210	280	16
H4	230	300	10

Data Sheet

6061 (Heat-Treatable) **Al-Mg-Si**

Chemical Composition Limits (in %) (Single figures denote maxima)

Cu	Mg	Si	Fe	Mn	Zn	Ti	Cr	Other elements Each	Other elements Total
0.15 0.40	0.8- 1.2	0.4- 0.8	0.7	0.15	0.25	0.15	0.04- 0.35	0.05	0.15

Outstanding Characteristics:
Severe forming possilbe in annealed or solution heat treated conditions. Full properties developed by heat treatment. Medium strength. Good corrosion resistance. Good weldability, brazeability and anodizing response.

Standard Commodities:
Extrusions, bars and hollow shapes.

Typical Uses:
Structural engineering, road and rail transport

Typical Physical Properties

Density	2.70	g/cm^3
Modulus of Elasticity	69	GPa
Modulus of Rigidity	26	GPa
Melting Range	580-650	°C
Specific heat between 0-100°C (273-373 K)	0.92	J/g°C
Coefficient of linear expansion between 20-200°C (293-373 K)	24×10^{-6}	/°C
Thermal Conductivity at 100°C (373K)	167	W/cm^3C
Resistivity at 20°C (293 K)	0.040×10^{-6}	Ωm

Other Characteristics

Corrosion Resistance	: Good
Weldability	: Good
Formability	: Good (in O & T4 temper)
Anodizing	: Good
Brazeability	: Good
Machinability	: Good (in T6 temper)

Typical Mechanical Properties

Temper	0.2% Proof Stress MPa	UTS MPa	%El in 50mm
O	100 max	150 max	14
T4	110	180	13
T6	240	260	6

Solution Heat Treatment

Temper	Temp. (°C)	Time (h)	Quenching	Ageing temp. (°C)
T6	530±3	8	In water	175±3

Anneal (to remove the effect of heat treatment) at 415±3 °C for 2-3 hours

Data Sheet

6063 (Heat-Treatable) Al-Mg-Si

Chemical Composition Limits (in %)

								Other elements	
Cu	Mg	Si	Fe	Mn	Zn	Ti	Cr	Each	Total
0.1	0.45 0.9	0.2 0.6	0.35	0.1	0.1	0.1	0.1	0.05	0.1

Outstanding Characteristics:

Medium strength alloy suitable for intricate extrusions.
High corrosion resistance.
Good formability in TB condition. Good surface finish.

Standard Commodities:

Extrusions (sections, square and round tubing)

Typical Uses:

Architectural members such as window frames and glazing bars; irrigation tubing.

Typical Physical Properties

Density	2.71	g/cm^3
Modulus of Elasticity	67	GPa
Modulus of Rigidity	25.5	GPa
Melting Range	600-650	°C
Specific heat between 0-100°C (273-373 K)	0.88	J/g°C
Coefficient of linear expansion between 20-200°C (293-473 K)	23×10^{-6}	/°C
Thermal Conductivity at 100°C (373K)	180-218	W/m°C
Resistivity at 20°C (293 K)	0.035×10^{-6}	Ωm

Other Characteristics

Corrosion Resistance	: Very Good
Weldability	: Good
Formability	: Good (in TB temper)
Anodizing	: Very Good
Brazeability	: Good

Typical Mechanical Properties

Temper	0.2% Proof Stress MPa	Ultimate Tensile Strength MPa	% Elongation in 50 mm
TB	70	130	14
TF	160	185	7

Data Sheet

6082 (Heat-Treatable) **Al-Mg-Si (M82)**

Chemical Composition Limits (in %)

								Other elements	
Cu	Mg	Si	Fe	Mn	Zn	Ti	Cr	Each	Total
0.1	0.6	0.7	0.5	0.4	0.2	0.1	0.25	0.05	0.15
	1.2	1.3		1.0					

Outstanding Characteristics:

Medium strength alloy with good corrosion resistance.

Standard Commodities:

Plate, extrusions.

Typical Uses:

For stressed structural applications, such as bridges, cranes, roof trusses, transport applications. Beer barrels; milk churns.

Typical Physical Properties

Density	2.70	g/cm^3
Modulus of Elasticity	70	GPa
Modulus of Rigidity	26.5	GPa
Melting Range	555-650	°C
Specific heat between 0-100°C (273-373 K)	0.88	J/g°C
Coefficient of linear expansion between 20-200°C (293-473 K)	24×10^{-6}	/°C
Thermal Conductivity at 100°C (373K)	180-189	W/m°C
Resistivity at 20°C (293 K)	0.038×10^{-6}	Ωm

Other Characteristics

Corrosion Resistance	: Good
Weldability	: Good
Formability	: Good
Machinability	: Good
Anodizing	: Good
Brazeability	: Good

Typical Mechanical Properties

Temper	0.2% Proof Stress MPa	Ultimate Tensile Strength MPa	% Elongation in 50 mm
TF	270	310	7

Stock

Coil

Thickness (mm)	Width (mm)	Alloy	Temper	Theoretical mass (kg/mtr)
0.5	1000	1200	H4	1.36
0.7	1000	1200	H4	1.89
0.9	1000	1200	H4	2.44

Sheet

Thickness (mm)	Length (mm)	Width (mm)	Alloy	Temper	Theoretical mass (kg/sheet)
0.5	2000	1000	1200	H4	2.71
	2500	1250	1200	H4	4.23
0.7	2000	1000	1200	H4	3.79
	2500	1250	1200	H4	5.93
0.9	2000	1000	1200	H4	4.88
	2500	1250	1200	H4	7.62
	2500	1250	5251	H6	7.57
1.2	2000	1000	1200	H4	6.5
	2500	1250	1200	H4	10.16
	2500	1250	5251	H6	10.01
	3000	1500	1200	H4	14.63
1.6	2000	1000	1200	H4	8.67
	2500	1250	1200	H4	13.55
	2500	1250	5251	H6	13.45
	3000	1500	1200	H4	19.51
2.0	2000	1000	1200	H4	10.84
	2500	1250	1200	H4	16.94
	2500	1250	5251	H6	16.81
	3000	1500	1200	H4	24.39
2.5	2500	1250	1200	H4	21.17
3.0	2000	1000	1200	H4	16.26
	2500	1250	1200	H4	25.40
	2500	1250	5251	H3	25.88
	2500	1250	5251	H6	25.88
	3000	1500	1200	H4	36.58

➢ 'Aluvan' 3004 sheet and coil in H2 or H4 Temper, available on request.

Plate

Thickness (mm)	Length (mm)	Width (mm)	Alloy	Temper	Theoretical mass (kg/plate)
4.5	2000	1000	1200	H4	25.11
	2500	1250	1200	H4	38.10
6.0	2500	1250	1200	H4	52.31
	2500	1250	5251	H3	51.75
	2500	1250	6082	T6	51.75
9.5	2500	1250	1200	H4	82.83
	2500	1250	6082	T6	82.83
12	2500	1250	6082	T6	101.62
16	2500	1250	6082	T6	136.0
20	2500	1250	6082	T6	170.0
25	2500	1250	6082	T6	212.0
30	2500	1250	6082	T6	255.0
40	2500	1250	6082	T6	232.0
50	2500	1250	6082	T6	423.44

*Thicker plate and cut to size available. Enquire for details.

Treadplate

(5 Bar Pattern)

Base Thickness (mm)	Length (mm)	Width (mm)	Alloy	Temper	Theoretical mass (kg/plate)
1.5	2500	1250	1200	H4	15.88
	3000	1500	1200	H4	21.89
2.0	2500	1250	1200	H4	17.28
3.0	2500	1250	1200	H4	28.6
	2500	1250	5251	H4	27.91
4.5	2500	1250	1200	H4	42.0
	2000	1250	5251	H4	40.61
6	2500	1250	5454	H2	53.31

➢ Aluminium building sheet and complementary products available ex-stock. Enquire for details

Treadbright Treadplate

Propeller Pattern

1.473	2438	1219	3003	H2	15.2	
1.829	2438	1219	3003	H2		18.88
2.032	2438	1219	3003	H2		19.44
3.175	2438	1219	3003	H2	27.91	

Stock

Single Form Walkway

Base Thickness (mm)	Width (mm)	Length (mm)	Alloy	Temper	Theoretical mass (lin/mtr)
3m	250	Variable	5042	0	4.13
3m	475	Variable	5042	0	5.13

Stucco Sheet

Base Thickness (mm)	Length (mm)	Width (mm)	Alloy	Temper	Theoretical mass (kg/mtr)
0.9	2500	1250	1200	H4	7.62
1.2	2000	1250	1200	H4	10.16

Round Bar

Dia (mm)	Alloy	Temper	Theoretical mass (kg/m)
4.5	6261	T6	0.043
6.0	6261	T6	0.076
8.0	6261	T6	0.136
10.0	6261	T6	0.213
12.0	6261	TF	0.306
16.0	6261	T6	0.537
20.0	6261	T6	0.851
25.0	6261	T6	1.330
32.0	6261	T6	2.180
35.0	6261	T6	2.607
40.0	6261	T6	3.410
45.0	6261	T6	4.301
50.0	6261	T6	5.321
57.0	6261	T6	6.915
65.0	6261	T6	8.993
75.0	6261	T6	11.972
80.0	6261	T6	13.622
90.0	6261	T6	17.240
100.0	6261	T6	21.284
115.0	6086	T6	28.150
125.0	6082	T6	33.257
130.0	6082	T6	35.970
140.0	6082	T6	41.630
150.0	6082	T6	49.434
180.0	6082	T6	62.270
200.0	6082	T6	87.800
250.0	6082	T6	137.500
300.0	6082	T6	197.200

Channel, Angles (Equal and Unequal Leg), Flat bar, Round tubing, Square tubing and Square bar are available upon enquiry.

Sections for mine shaft conveyances available ex -stock. Enquire for details.

Roof Sheeting

1. **Corrugated 10/3 (Alloy 3004) - conforms to SABS 903-1978**
2. **Industrial 7 (Alloy 3004) - conforms to SABS 903-1978**

Walkway (Alloy 5042)

Standard width of 475mm and standard length of 6.0m. Other lengths available on request.