Cr - Ni AUSTENITIC

stainless steel

Adding stainless quality to life

COLUMBUS STAINLESS [Pty] Ltd

Disclaimer

The data, results, content and information contained in this document have been produced in good faith by Columbus Stainless (Pty) LTD, based on its up-to-date technical expertise, tools and knowledge, and regarding the data, samples and/or requests which were delivered. The information, analysis, data and results which may arise or to be derived from this document are not intended to replace procedures, studies, testing and/or analyses carried out by experts and should not be used nor taken into account for any application and/or utilization of it, either specific or generic in nature, without previously receiving specific professional advisement regarding what metallurgical, physical, chemical properties, or any other specific area, may apply. Furthermore, neither do the information, analysis, data and results contained in this document intent to constitute an exhaustive or complete report regarding any of the characteristics, results and data that is applicable or relative to the products or materials it contains, especially given the countless number of purposes and destinations of the products and materials hereby described, and the variables and the circumstances which may affect them. This document is property of Columbus Stainless (Pty) LTD, and may not be utilized for purposes other than those which it has been intended. The total or partial reproduction, either direct or indirect, of its content, as well as its distribution, translation, remission, transformation or utilisation by any means, system or procedure remains strictly prohibited without the prior written consent of Columbus Stainless (Pty) LTD. Columbus Stainless (Pty) LTD, its agents and consultants are exempt from any responsibility regarding the information, data, results and contents of this document, and therefore bear no responsibility regarding for any direct or indirect damage, loss or harm cause to any person or organisation, no matter its cause, which may be derived or related to the content of this document or the omission from it. In particular, Columbus Stainless (Pty) LTD, bears no responsibility for the extrapolation or generalisation of this content, results, information or data. The use of this information contained in this document is considered to represent the expressed acceptance of this clause or legal disclaimer.

cedinox

©Madrid 2026 ACERINOX.
All rights reserved. Designed by Cedinox 082026

Cr - Ni
AUSTENITIC
stainless steel

Introduction

The **Cr-Ni austenitics** are the most versatile and widely used of all the stainless steels. Their chemical composition, mechanical properties, weldability and corrosion/oxidation resistance provide the best all-round performance stainless steels at relatively low cost. They have excellent low temperature properties and respond well to hardening by cold working.

The carefully controlled chemical composition of the **Cr-Ni austenitics** enables them to be deep drawn without intermediate annealing. This has made them dominant in the manufacture of drawn stainless steel parts such as sinks and saucepans. They are readily press-braked or roll formed into a variety of shapes for applications in the industrial, architectural and transportation fields.

301L/301LN

type grades have lower Ni and Cr than 304 grades and typically used in the automotive trimming market. Type 301L/301LN has good ductility and formability combined with weldability that is similar to 304 grades.

The 301L/301LN grades have a PRE number slightly lower than 304 material.

304L-304LDDQ

are low carbon grades that do not require post weld annealing and find extensive use in heavy gauge components where freedom from carbide precipitation is often required.

304 - 304H - 304DQ-304DDQ

are high carbon grades and have good welding characteristics. There is, however, a risk of carbide precipitation and sensitisation with a possible concomitant loss in intergranular corrosion resistance in corrosive environments in thicker gauges. Post weld annealing is not normally required to restore the excellent performance of these grades in a wide range of corrosive conditions.

304H

with a higher carbon content, is normally specified where good mechanical properties at elevated temperatures are required.

These grades also have a larger grain sizes (ASTM 7 or coarser) to improve the high temperature creep resistance.

304DQ - 304DDQ - 304LDDQ

The drawing quality (304DQ) and deep drawing quality (304DDQ and 304LDDQ) grades have increased levels of nickel to improve their formability and are thus used in forming operations where the depth of the formed part exceeds the diameter.

304LN

has a higher nitrogen content to improve the strength and is also particularly suitable for cryogenic applications.

321

is a titanium stabilised version of 304 and is used in applications exposed to the temperature range 450°C to 850°C where there is a high risk of sensitisation. 321 has higher elevated temperature properties than 304. Although having good resistance to oxidation and sensitisation, CS321 is unsuitable for use in highly oxidising environments due to possible 'knifeline' attack. Typical applications for CS321 would include furnace parts, after burners, expansion bellows, compensators, catalytic converters, etc.

Product range

The latest revision of the Product Catalogue should be consulted, as the product range is subject to change without notice.

The Product Catalogue is available from the Technical Department or can be found at www.columbus.co.za

Specifications and tolerances

Columbus Stainless (Pty) Ltd supplies the Cr-Ni austenitics to ASTM A240, ASME SA240, JIS, EN 10088-2 and EN 10028-7.

Columbus Stainless (Pty) Ltd normally supplies material to the following tolerances:

HOT ROLLED

ISO 9444 - material processed as coil		ISO 9444-2	
ISO 18286 - material processed as plate		ISO 18286	
ASTM A480	ASTM A480M	EN 10051	EN 10029
ASME SA480	ASME SA480M	IS 6911	
JIS G 4304	JIS G 4312		

COLD ROLLED

ISO 9445	ISO 9445-2
ASTM A480	ASTM A480M
ASME SA480	ASME SA480M
IS 6911	
JIS G 4305	JIS G 4312

Other specifications and tolerances may be available on request.

Further information is available in the Product Catalogue, which can be obtained from the Technical Department or can be found at www.columbus.co.za

Further information:

TECHNICAL

Columbus Stainless (Pty) Ltd
PO Box 133 • Middelburg • 1050 • South Africa
Tel: +27 (13) 247 3343
Fax: +27 (13) 247 2289
E-mail: technical-help@columbus.co.za

COMMERCIAL

Columbus Stainless (Pty) Ltd
PO Box 133 • Middelburg • 1050 • South Africa
Tel: +27 (13) 247 2020
Fax: +27 (13) 247 2771
E-mail: commercial-help@columbus.co.za

Cr - Ni
AUSTENITIC
stainless steel

Chemical composition

In accordance with the Columbus Stainless mill specification, ASTM A240 and EN 10088-2.

	C	Si	Mn	P	S	N	Cr	Ni	Other
301L/301LN	0.03	1.00	2.0	0.045	0.015	0.07-0.20	16.0-18.0	6-8	
304 304H	0.07	0.75	2.0	0.045	0.015	0.10	18.0-19.5	8.0-10.5	
304DQ	0.07	0.75	2.0	0.045	0.015	0.10	18.0-19.5	8.5-10.5	
304DDQ	0.07	0.75	2.0	0.045	0.015	0.10	18.0-19.5	9.0-10.5	
304L	0.03	0.75	2.0	0.045	0.015	0.10	18.0-19.5	8.0-10.5	
304LDDQ	0.03	0.75	2.0	0.045	0.015	0.10	18.0-20.0	10.0-10.5	
304LN	0.03	0.75	2.0	0.045	0.015	0.10-0.16	18.0-20.0	8.0-12.0	
321	0.08	0.75	2.0	0.045	0.015	0.10	17.0-19.0	9.0-12.0	Ti : 5x(C+N)0.7

Compositions are ranges or maximum values.

Mechanical properties

In accordance with ASTM A240, EN 10088-2 and EN 100095, where applicable.

	Rm (MPa)	$Rp_{0.2}$ (MPa)	$Rp_{1.0}$ (MPa)	Elongation (%)	Max Hardness (HRB)
301L/301LN	550	220		45	100
304 304H 304DQ 304LDDQ	540 to 750 (CR) 520 to 720 (HR)	230 (CR) 210 (HR)	260 (CR) 250 (HR)	45	92
304L 304LDDQ	520 to 700 (≤8 mm) 500 to 700 (>8 mm)	220 (CR) 200 (HR)	250 (CR) 240 (HR)	45	92
304LN	515	205		40	95
321	520 to 700 (≤8 mm) 500 to 700 (>8 mm)	220 (CR) 200 (HR)	250 (CR) 240 (HR)	40	95

Minimum values, unless Max or range is indicated.
() Indicates applicable gauge range.
CR = Cold Rolled - HR = Hot Rolled

PROPERTIES AT ELEVATED TEMPERATURES

The properties quoted below are typical of annealed 304, 304L, and 321 type steels. These values are given as a guideline only, and should not be used for design purposes.

Short time elevated temperature tensile strength (MPa)

	100°C	200°C	300°C	400°C	500°C	600°C	700°C	800°C	900°C	1000°C	1100°C
304 types	530	510	480	450	400	320	230	135	70	40	30
304L types	480	460	440	400	350	280	200	120	50	25	15
321	525	520	510	470	420	340	260	180	105	60	25

Short time elevated temperature 0.2 proof stress (MPa)

	100°C	200°C	300°C	400°C	500°C	600°C	700°C	800°C
304 types	220	160	145	140	125	110	95	70
304L types	200	145	130	125	110	95	85	60
321	210	185	165	155	140	130	115	95

Short time elevated temperature elongation (%)

	100°C	200°C	300°C	400°C	500°C	600°C	700°C	800°C	900°C	1000°C	1100°C
304 types	52	45	41	38	36	34	35	38	48	66	96
304L types	52	45	40	38	36	36	38	43	52	68	90
321	52	44	39	38	39	43	48	54	62	73	87

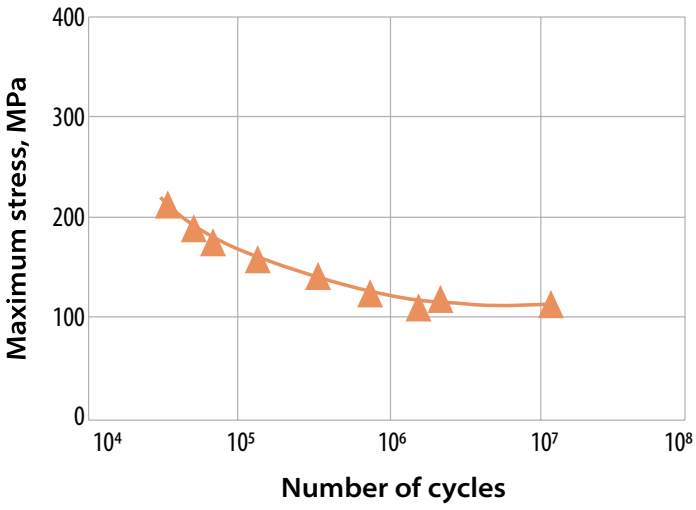
Maximum recommended service temperature

	Continuous °C	Intermittent °C
All 304/304L/321 types	830	800

In oxidizing conditions

FATIGUE CONSIDERATION

When looking into the fatigue of austenitic stainless steels, it is important to note that design and fabrication - not material, are the major contributors to fatigue failure. Design codes (e.g. ASME and BS 5500) use data from low-cycle fatigue tests carried out on machined specimens to produce conservative S-N curves used with stress concentration factors (k1 c) or fatigue strength reduction factors (k1). In essence, the fatigue strength of a welded joint should be used for design purposes, as the inevitable flaws (even only those of cross-sectional change) within a welded will control the overall fatigue performance of the structure. The adjacent curve shows a typical S-N curve for U-304 stainless steel (longitudinal).



Cr - Ni
AUSTENITIC
stainless steel

Physical properties

The values given below are for 20°C, unless otherwise stated.

		All 304-304L types	321
Density (kg/m³)		7900	7800
Modulus of Elasticity in Tension (GPa)		193	193
Modulus of Elasticity in Torsion (GPa)		86	86
Specific Heat Capacity (J/kg K)		500	500
Thermal Conductivity at	100°C (W/m K)	16.2	16.1
	500°C (W/m K)	21.5	22.2
Electrical Resistivity (x10^{-9} Ω m)		720	720
Mean Coefficient of Thermal Expansion from	0 to 100°C (x10^{-6} K^{-1})	17.2	16.6
	0 to 300°C (x10^{-6} K^{-1})	17.8	17.2
	0 to 500°C (x10^{-6} K^{-1})	18.4	18.6
	0 to 700°C (x10^{-6} K^{-1})	18.9	19.0
Melting Range (°C)		1400 1450	1400 1450

May become slightly magnetic in the cold worked condition.

Thermal processing and fabrication

ANNEALING

Annealing of 304 and 304L type steel is achieved by heating to between 1010°C and 1120°C for 60 minutes per 25 mm thickness (2.5 min/mm) followed by water or air quenching. The best corrosion resistance is achieved when the final annealing temperature is above 1070°C.

321 should not be annealed above 1060°C.

Controlled atmospheres are recommended in order to avoid excessive oxidation of the surface.

WELDING

The Cr-Ni austenitics have good welding characteristics and are suited to all standard welding methods. Either matching or slightly over-alloyed filler wires should be used, such as 308L.

For maximum corrosion resistance, the higher carbon type 304 should be annealed after welding to dissolve any chromium carbides which may have precipitated. The weld discolouration should be removed by pickling and passivation to restore maximum corrosion resistance.

COLD WORKING

The Cr-Ni austenitics are extremely tough and ductile and can thus be readily deep drawn, stamped, headed and upset without difficulty. Since austenitic stainless steels work harden, severe cold forming operations should be followed by annealing.

STRESS RELIEVING

The lower carbon grade (304L types) can be stress relieved at 450°C to 600°C for 45 minutes per 25 mm thickness (1.5 min/mm) with little danger of sensitisation.

A lower stress relieving temperature of 400°C maximum must be used with 304 types with longer soaking times.

If, however, stress relieving is to be carried out above 600°C, there is a serious threat of grain boundary sensitisation occurring with a concomitant loss in corrosion resistance. In this instance, 321 (titanium stabilised) should be used.

HOT WORKING

The Cr-Ni austenitics can be readily forged, upset and hot headed. Uniform heating of the steel in the range of 1150°C to 1250°C is required. The finishing temperature should not be below 900°C. Upsetting operations and forgings require a finishing temperature between 930°C and 980°C. Forgings should be air cooled. All hot working operations should be followed by annealing and pickling and passivation to restore the mechanical properties and corrosion resistance.

MACHINING

Like all the austenitic stainless steels, this alloy group machines with a rough and stringy swarf. Rigidly supported tools with as heavy a cut as possible should be used to prevent glazing.

Some recommendations

Handling and transport

Before shipping, make sure every chain and steel element is not in contact with stainless steel. Raffia or wooden elements must be used at possible contact places.

When outside storage is required, material should be covered by a waterproof canvas.

Avoid contact with the ground using wooden blocks and store stainless steel and carbon steel separately. This way we avoid problems with contamination by oils, dirt or by contact among different materials.

When stainless steel has to be moved with lift trucks, the forks should be protected with nylon.

Avoid carbon steel slings, use nylon or polypropylene ones wherever possible.

Fabrication and installation

Make sure stainless steel is contamination free before starting to work. If there is any, it will be removed by pickling or mechanical means (*).

If cleaning is required, do it with pressurized water. Do not use sea or brackish water.

All tools employed in the installation must be made of stainless steel and these should have been never used with carbon steel. If this is not possible, tools must be carefully cleaned before use.

Stainless steel should be processed in machines exclusively dedicated to this material, in order to avoid contamination by projections or oxide traces from other materials.

Excessive temperature oxidation or *blueing* due to abrasive cutting, should be removed with pickling paste. Good refrigerated cutting tools help to avoid the problem.

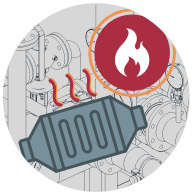
If coating may be considered for aesthetic reasons, surface preparation is extremely important and may be performed either by acid pickling or mechanical means such as blasting.

(*) It is always advisable to contact the supplier

Some applications

Catering equipment
Deep drawing parts
Architectural &
Industrial fields

Transportation sector



321

Catalytic converters

Furnace parts, after burners

Expansion bellows, compensators

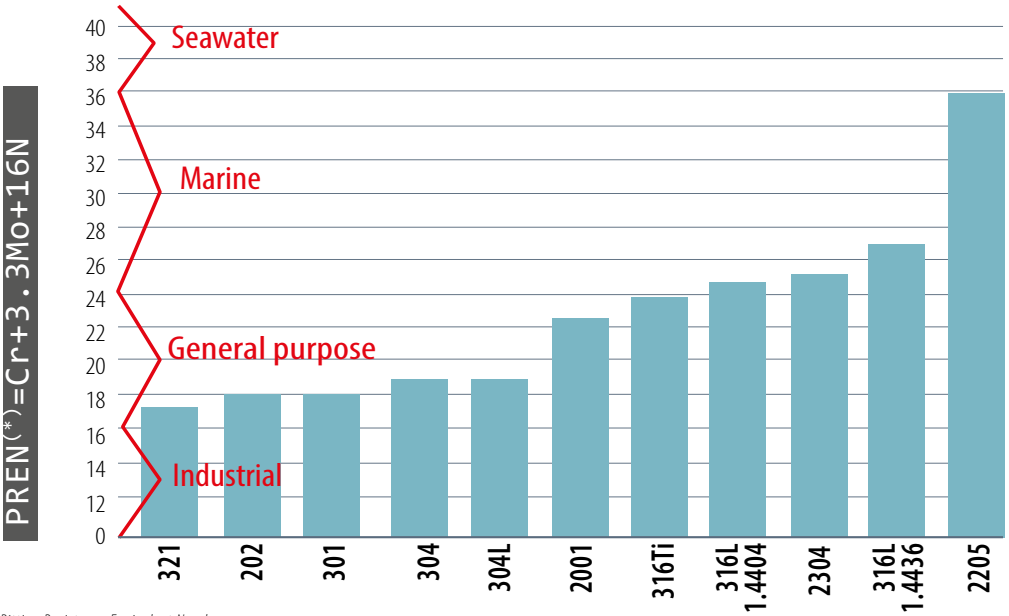
304LN

Cryogenic applications

Resistance to corrosion

The diagram summarises the corrosion (pitting) resistance of the austenitic and duplex stainless steels produced at Columbus Stainless.

This would indicate that the corrosion resistance of the Cr-Ni austenitic types are all similar and suitable for general purpose applications.

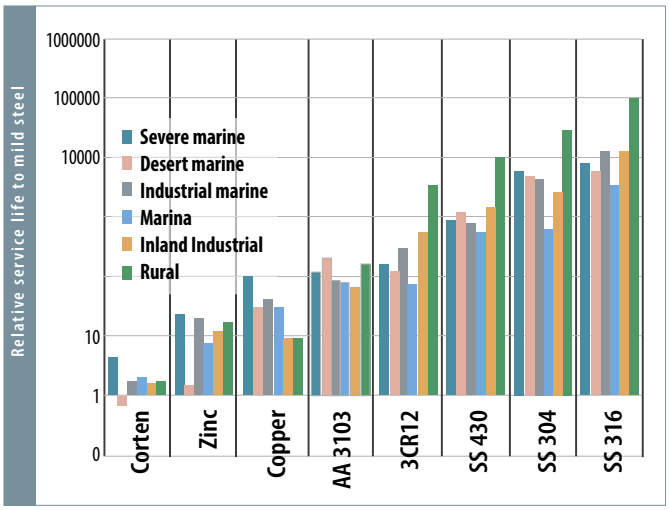


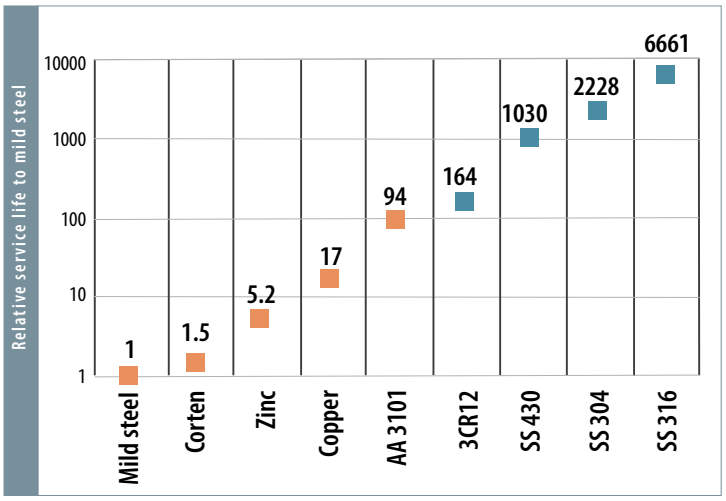
*Pitting Resistance Equivalent Number

ATMOSPHERIC CORROSION

The atmospheric corrosion resistance of austenitic stainless steel is unequalled by virtually all other uncoated engineering materials. From the report 'Atmospheric Corrosion Testing in Southern Africa - Results of a Twenty Year Exposure Programme' by BG Callaghan, Division of Materials Science and Technology, CSIR, the adjacent graphs can be constructed. This shows the relative life of eight metals compared to mild steel in six different atmospheric environments.

These graphs can be summarised to give an average relative life of the different metals in atmospheric conditions. In appearance, all the metals showed discolouration at the more severe sites after 20 years. None of the metals were washed during the exposure programme and this clearly emphasises the importance of keeping stainless steel clean and that stainless steel is a LOW maintenance (not NO maintenance) option in atmospheric corrosion applications.



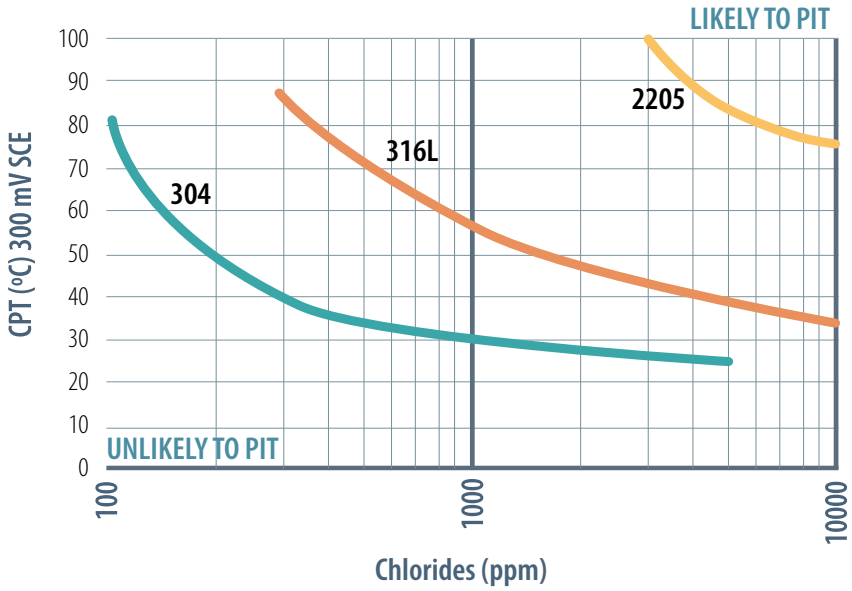


GENERAL CORROSION

The Cr-Ni austenitics have good general corrosion resistance in a wide variety of corrosive media, including foodstuffs, sterilising solutions, most organic chemicals and dyes and a wide variety of inorganic chemicals.

PITTING CORROSION

Pitting resistance is important, mainly in applications involving contact with chloride solutions, particularly in the presence of oxidising media. These conditions may be conducive to localised penetration of the passive surface film on the steel and a single deep pit may well be more damaging than a much greater number of relatively shallow pits. Where pitting corrosion is anticipated, steels containing molybdenum (such as the Cr-Ni-Mo austenitics) should be considered. The diagram shows the critical temperature for initiation of pitting (CPT) at different chloride contents for 304, 316 and 2205 types (potentiostatic determination at +300mV SCE, pH = 6.0).



OXIDATION RESISTANCE

Cr-Ni austenitics types have good oxidation resistance. Continuous use of the 304 types in the 450°C to 850°C temperature range is not recommended due to carbide precipitation but 304 often performs well in temperatures fluctuating above and below this range. One should use the low carbon 'L' variant in these applications.

STRESS CORROSION CRACKING

Stress corrosion cracking (SCC) can occur in austenitic stainless steels when they are stressed in tension in chloride environments at temperatures in excess of about 60°C. The stress may be applied, as in a pressure system, or it may be residual arising from cold working operations or welding. Additionally, the chloride ion concentration need not be very high initially, if locations exist in which concentrations of salt can accumulate.

Assessment of these parameters and accurate prediction of the probability of SCC occurring in service is therefore difficult. Where there is a likelihood of SCC occurring, a beneficial increase in life can be easily obtained by a reduction in operating stress and temperature. Alternatively, specially designed alloys, such as duplex stainless steels, will have to be used where SCC cracking is likely to occur.

INTERGRANULAR CORROSION

Sensitisation may occur when the Heat Affected Zones of welds in some austenitic stainless steels are cooled through the sensitising temperature range of between 450°C and 850°C. At this temperature, a compositional change may occur at the grain boundaries.

If a sensitised material is then subjected to a corrosive environment, intergranular attack may be experienced. This corrosion takes place preferentially in the heat affected zone away from and parallel to the weld. Susceptibility to this form of attack, often termed 'weld decay', may be assessed by the following standard tests:

a) boiling copper sulphate/sulphuric acid test as specified in ASTM A262, Practice E,

b) for non titanium stabilised grades only, boiling nitric acid test as specified in ASTM A262, Practice C.

In the more severe nitric acid test, some weldments in plates of 304 may exhibit slight intergranular corrosion. For service in the as-welded condition in severe chemical environments,304L would be recommended in preference to 304.

Certificates

Columbus Stainless' product meets the following international standards:

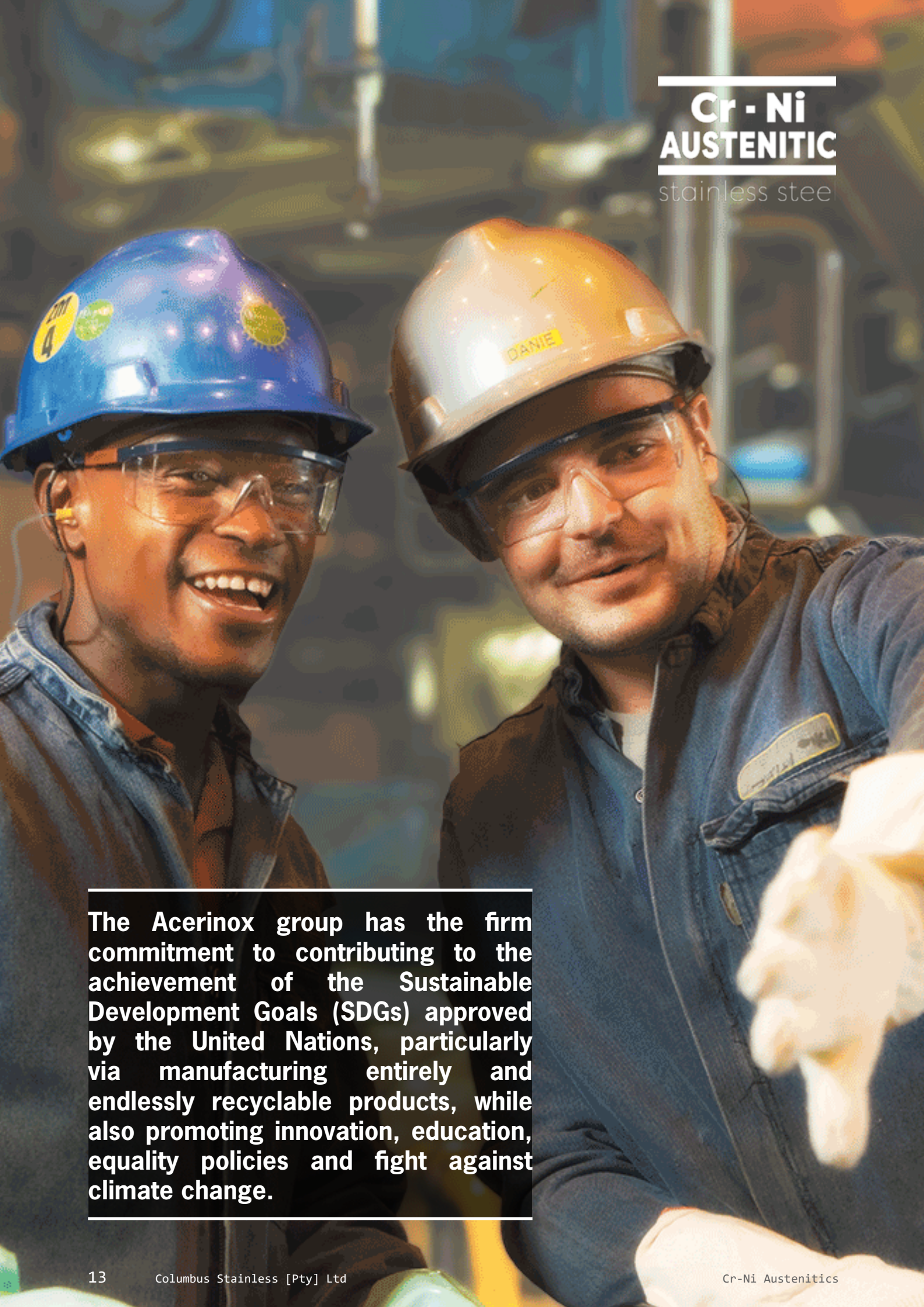
PED 2014/68/EU Certificate	BIS Certification Mark License
CPR 305/2011/EU Certificate	PESR Certificate
CPR Declaration of Performance	JIS G4304 & G4305 Certificate of Compliance
	JIS G4312 Certificate of Compliance

Available at www.columbus.co.za/quality/product-certifications or scan the code:

Committed to sustainable growth

Acerinox is one of the major scrap recyclers wherever it is located. The production in the factories of Acerinox is transformed into final products which return to the factories as scrap to be melted again. This is a cycle that could be infinite due to the material properties.

Columbus Stainless also ensures optimum utilisation of raw materials and energy sources by focusing on the reduction of waste in both power, water and raw materials. Not only do these reduce the impact on the environment but also reduce the costs of producing quality products.



The Acerinox group has the firm commitment to contributing to the achievement of the Sustainable Development Goals (SDGs) approved by the United Nations, particularly via manufacturing entirely and endlessly recyclable products, while also promoting innovation, education, equality policies and fight against climate change.

Acerinox: the confidence of a strong group

Acerinox is the Spanish multinational global leader in stainless steel manufacturing. With a total production capability of 3.5 million tonnes per year. Acerinox owns factories worldwide confirming its global presence, stainless steel flat products manufacturing at Acerinox Europa, North American Stainless and Columbus Stainless; and Roldan, Inoxfil and North American Stainless for long products manufacture. In March 2020, VDM Metals, worldwide leader in high performance alloys manufacture and design, has also become part of the group. In November 2024, Acerinox completes the acquisition of Haynes International, U.S. leading manufacturer and marketer of technologically advanced high-performance alloys.

Every Acerinox facility satisfies the quality and environmental controls required by each country legislation, apart from the application of the Environmental Management System according to ISO 14001. Furthermore, subsidiaries assume higher standards than legal requirements in areas such as quality, safety and sustainability.

Scrap plays a key role in all Acerinox fabrication processes. Thus, a great value is added bringing it back to the material life cycle, reducing the environmental impact with the use of the same material for centuries.

Columbus Stainless was founded in 1966 in South Africa. It is the only integrated stainless steel factory on the African continent and today is the main supplier of stainless steel solutions for both the domestic and the continent market.

The factory is equipped with the most efficient and technologically advanced machinery in the sector, has seen the most significant technological advances in the sector, and has a considerable competitive advantage due to its location, not only for distributing its finished products, but also thanks to its proximity to the raw material extraction sources, especially chrome. It also supplies semi-finished flat products to other Acerinox Group factories.

Columbus Stainless is the premier Stainless Steel Manufacturer and Provider in Africa. Our plant is technologically advanced, fully integrated and a single-site operation. This gives us flexibility to adjust quickly to changes in the market. We supply high-quality flat-rolled stainless and carbon steel products.

ACERINOX
ACERINOX EUROPA
ROLDAN S.A.
INOXFIL
NAS
VDM Metals
HAYNES International
COLUMBUS STAINLESS [Pty] Ltd
www.columbus.co.za