

# CLI - SAF 2507<sup>®</sup>

A 25 Cr Super Duplex stainless steel with PREN  $\geq$  40

CLI - SAF 2507<sup>®</sup> is a 25.07 super duplex stainless steel with 25% Cr and a PREN value higher than 40. The minimum guaranteed yield strength is 550 MPa which allows the designer to reduce weight. The molybdenum and nitrogen additions have been optimized in order to obtain the best corrosion resistance properties even for heavy plates. Its high nitrogen content improves the structure stability particularly in HAZ. The CLI - SAF 2507<sup>®</sup> (URANUS<sup>®</sup> 47N<sup>+</sup>) grade is an overalloyed variant of the former UR 47N grade of Industeel.

CLI - SAF 2507<sup>®</sup> has improved corrosion resistance properties when compared to duplex 2205 type materials, or even to URANUS<sup>®</sup> 47N. It is designed for service in severe corrosive conditions.

The alloy is particularly resistant to stress corrosion cracking and crevice corrosion.

CLI - SAF 2507<sup>®</sup> is a cost efficient grade designed for Oil & Gas industry, Seawater applications, Desalination plants, Geothermal wells or Refineries and Petrochemical plants.

*URANUS<sup>®</sup> is a trademark of USINOR INDUSTEEL - SAF 2507<sup>®</sup> is a Trademark of Sandvik AB*

## STANDARDS

EN 10088 - EN 10028.7 ..... X2 Cr Ni Mo N 25.6.3 - 1.4410  
AFNOR..... Z3 CND 25.07 AZ  
A.S.T.M. .... A 240 - UNS S 32750

For specific purposes PREN  $\geq$  38, values may be specified (UR 47N)

## CHEMICAL ANALYSIS

### Typical values (Weight %)

C	Cr	Ni	Mo	N	Others
< 0.030	25	6.5	3.6	0.26	-
PREN = [Cr %] + 3.3 [Mo %] + 16 [N %] $\geq$ 40					

## MECHANICAL PROPERTIES

### Tensile properties - minimum values

°C	Rp 0.2 MPa	Rp 1.0 MPa	Rm MPa	°F	YS 0.2% KSI	YS 1.0% KSI	UTS KSI	EI %
20	550	570	770	68	78	83	111	25
100	485	500	700	212	70	72	102	25
250	400	420	640	500	57	61	92	25

Typical temperature range of use : -50°C/+ 270° C (-58°F /+518°F)  
For lower temperature applications are also considered please contact us.

### Impact strength (KV typical values)

	-50°C (-58°F)	-20°C (-4°F)	0°C (32°F)	20°C (68°F)
KV plates (guaranteed)	> 70 J	> 85 J	> 90 J	> 95 J
KV weld metal (typical)	> 30 J	> 40 J	> 50 J	> 55 J

Impact values of welds are closely related to the microstructure ( $\alpha / \gamma$  balance) and the control of chemical analysis (oxygen, nitrogen, nickel) depend on welding processes and parameters. The best results are obtained for high austenite contents (75-60 %) and low oxygen levels. High nitrogen contents associated with high ferrite levels must be avoided. For more information, please contact us.

### Hardness values - Typical values

HV<sub>5</sub> : 250 to 280

HRC < 28

## PHYSICAL PROPERTIES

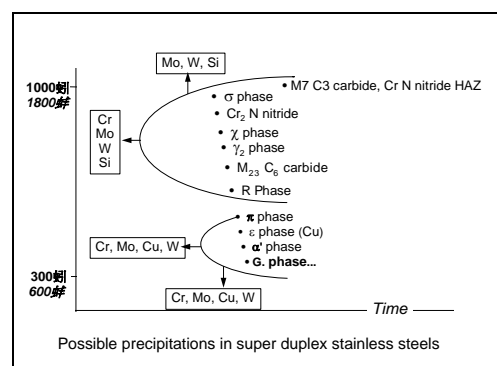
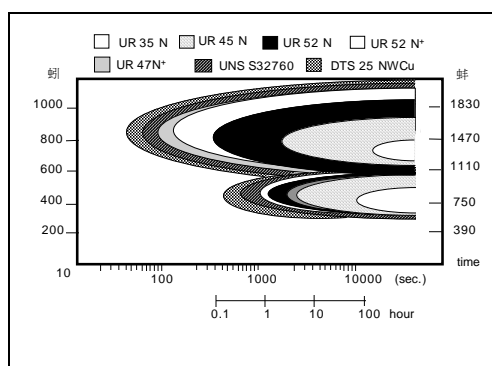
Density : 7,85 kg/dm<sup>3</sup>

Interval Temper °C	Thermal expansion $\alpha \times 10^{-6} K^{-1}$	°C	°F	Resistivity ( $\mu\Omega$ cm)	Thermal conductivity ( $W.m^{-1}.K^{-1}$ )	Specific heat ( $J.kg^{-1}.K^{-1}$ )	Young modulus E (GPa)	Shear modulus G (GPa)
20-200	13.5	20	68	85	17	450	200	75
20-300	14	100	392	95	18	500	190	73
20-500	14.5	200	392	100	19	530	180	70

## STRUCTURE STABILITY

25 Cr super duplex grades are subject to intermetallic phase precipitations ( $\sigma$ ,  $\chi$ ...) particularly when improperly heat treated. Higher molybdenum and tungsten additions increase the sensitivity to sigma phase transformation. Industeel equipments and heat treatments are optimised in order to control the composition, structure and properties of the products. The microstructure free of intermetallic phases contributes to an increase of both toughness properties and corrosion resistance properties.

Nitrogen additions have been increased compared to the former 25 Cr super duplex grade (0.18%  $\rightarrow$  0.25%) in order to increase both corrosion resistance properties and structure stability, particularly in HAZ.



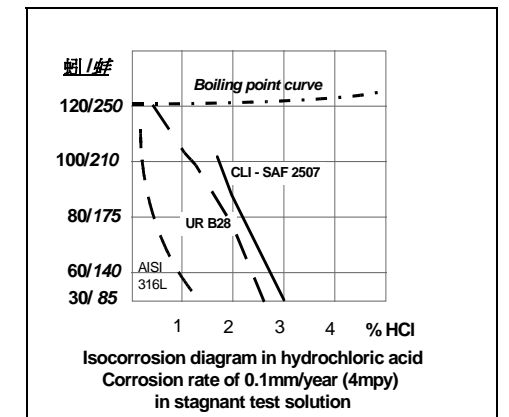
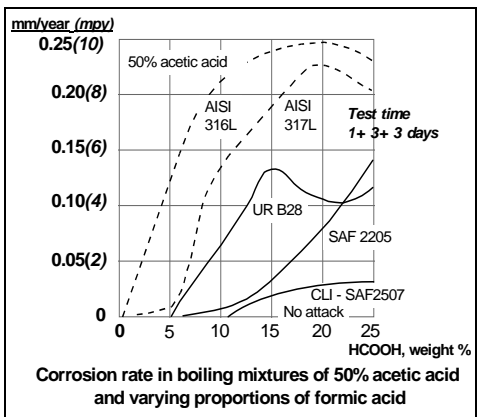
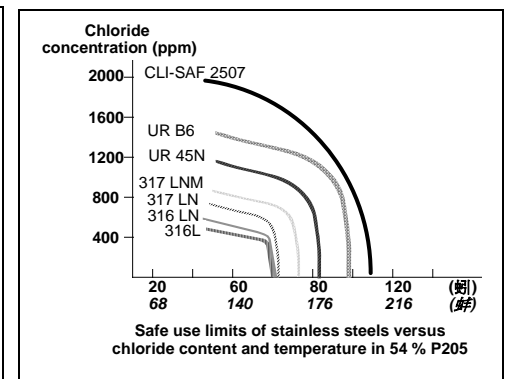
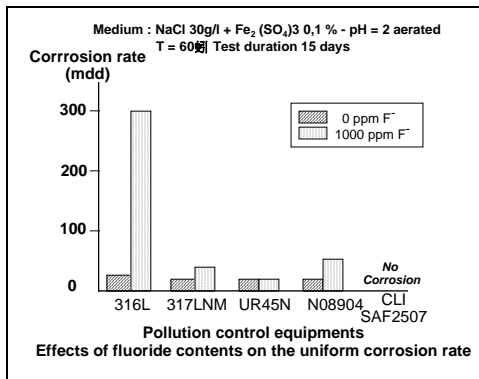
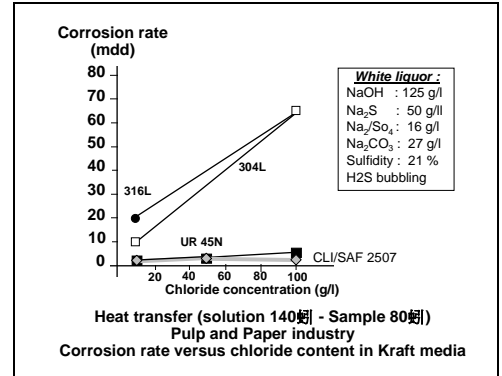
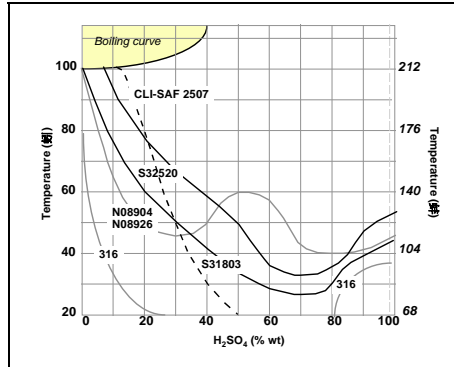
### Heat treatment :

CLI - SAF 2507 is delivered in the solution annealed and water quenched conditions (1080/1120°C - 1976/2018°F). The chemical analysis and heat treatment are optimised in order to reach nearly a 50%  $\alpha$  / 50%  $\gamma$  microstructure.

# CORROSION RESISTANCE

## General corrosion

CLI - SAF 2507 grade performs nearly as well as highly alloyed austenitic stainless steels in most of inorganic acids. For sulphuric acid solutions, copper containing, super-duplex grades should be preferred.

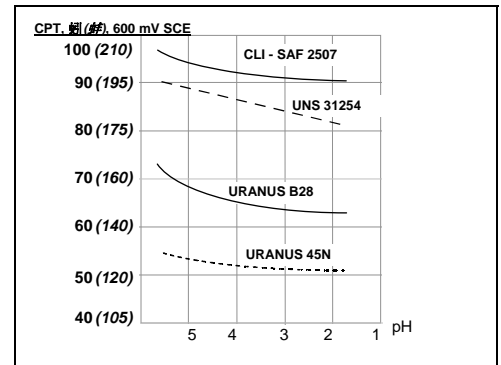
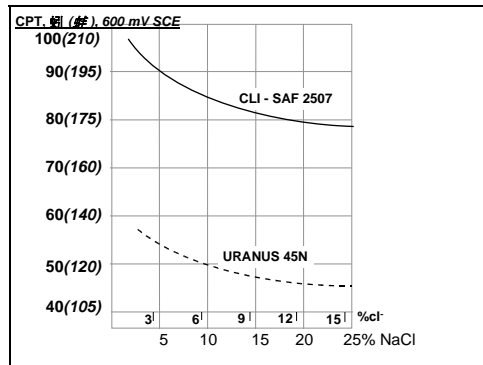
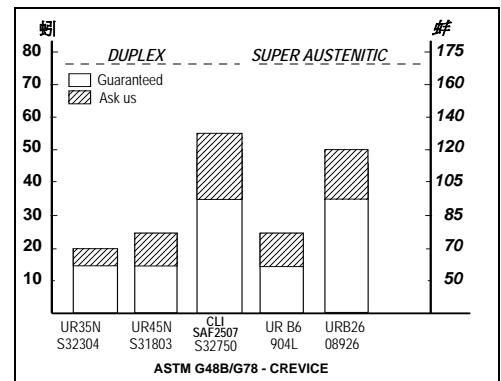
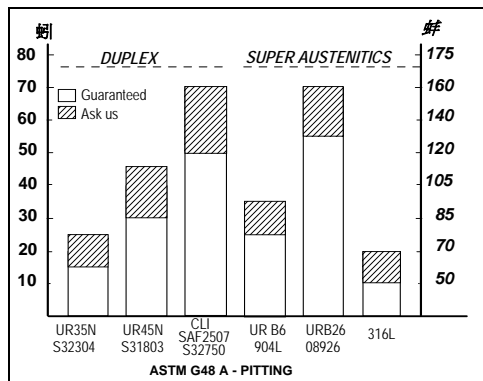
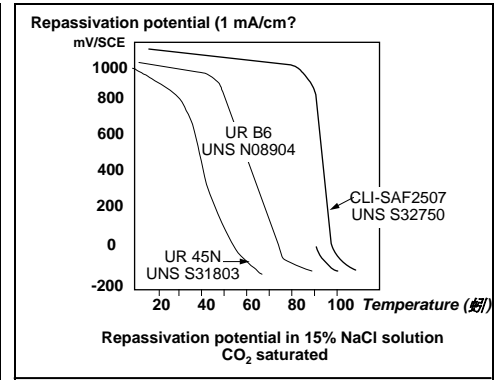
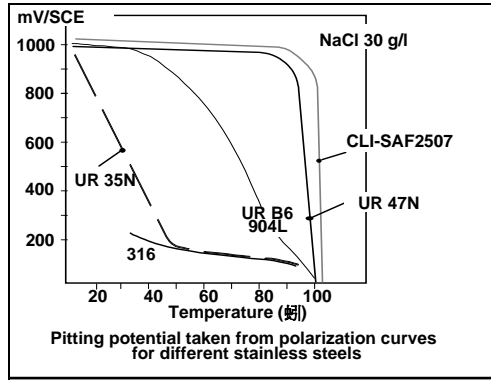


CLI - SAF 2507 is suitable for uses in organic acids including high concentration and temperatures where austenitic stainless steels corrode at a high rate.

## Pitting and crevice corrosion

The minimum PREN value ( [%Cr] + 3.3[% Mo] + 16[%N] ) of 40 also explains why the alloy is highly resistant to pitting and crevice corrosion. The alloy behaves much better than 904L and is, for pitting corrosion resistance, nearly equivalent to 6 Mo super g grade. In some cases, the crevice corrosion resistance is slightly higher than 6 Mo alloys due to the 25% Cr additions.

As usual pitting corrosion resistance properties is increased when testing thinner plates.

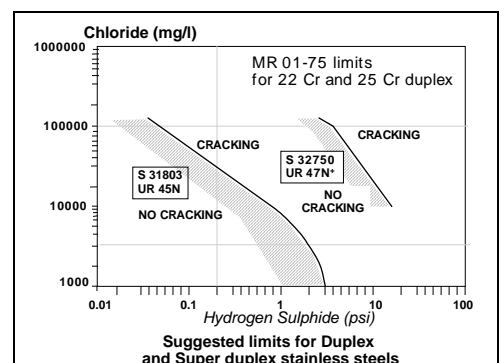
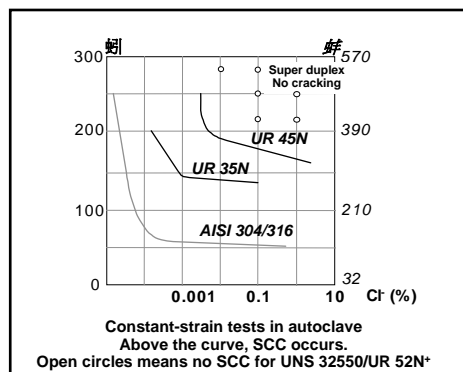


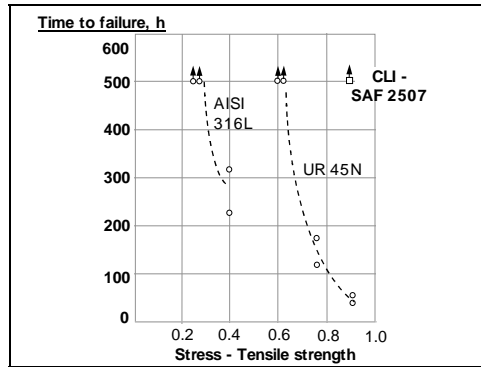
Critical pitting temperatures (CPT) at varying concentration of sodium chloride, from 3 to 25%

Critical pitting temperatures (CPT) in 3%NaCl with varying pH

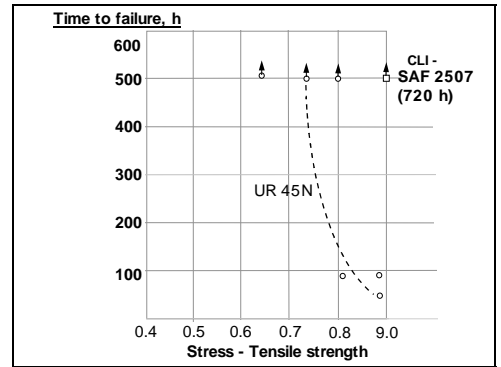
### Stress corrosion cracking resistance

The stress corrosion resistance (S.C.C.) properties of CLI - SAF 2507 grade are in excellent in high temperature chloride containing solutions as well as in sour gas applications.





Results of SCC tests with constant load in 40% CaCl<sub>2</sub>, pH=1,5, at 100°C (210°F) with aerated test solution.



Constant-load SCC tests in NACE-solution at room temperature (NACE TM-01-77)

## FABRICATION

### Cold forming

Due to its higher mechanical properties the cold forming of CLI - SAF 2507 grade requires, for cold forming, more strength than austenitic grades. For cold deformations higher than 20 %, an intermediate heat treatment is required (solution annealing 1080/1120°C (1976/2018°F) + water cooling).

Detailed guidelines for cold forming of unwelded and welded plates are available upon request.

### Hot forming

Between 1150°C and 1000°C (2102 and 1832°F). After hot forming, a new solution annealing heat treatment in the range 1080/1120°C (1976/2018°F) + water cooling is necessary.

### Pickling

Same conditions as for 316L grade, but the pickling time is at least twice that of 316L grade. An increase of the temperature of the pickling bath is recommended.

## WELDABILITY

CLI - SAF 2507 can be welded using the following processes : SMAW, GTAW (with filler), GMAW, PAW (with filler).

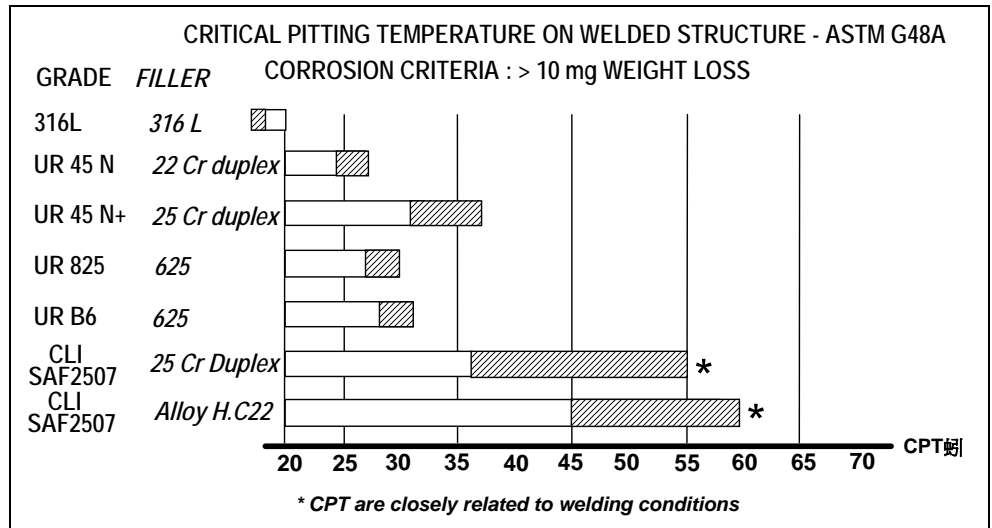
The welding procedure are similar to those of other duplex stainless steels

- no pre-heating,
- heat input between 0.5 kJ/mm and 2 JK/mm is generally recommended for hot rolled plates (depending on the process and on the thickness of the plate). Precise welding parameters for each welding process and thicknesses are available on request.
- interpass temperature less than 150°C (302°F) and preferably less than 120°C (248°F)
- no PWHT, except solution annealing at 1080/1120°C (1976/2048°F) + water cooling.

As in welded conditions, the ferrite ratio in the heat affected zone should be lower than 70% and between 20 to 60% for the weld metal or even better 20 to 40% ; for SMAW, and SAW weld metal aim for the lower part of the range (20 to 40%).

In order to control the structure and properties, over alloyed filler materials are recommended (nickel and/or nitrogen additions). Excessive dilutions must be avoided.

Filler materials and shielding gases guaranteeing PREN > 40 have been developed (wire, metallic cored wire, electrodes) - a list of tested filler materials is available on request.



Corrosion resistance properties of welded structures are very dependant on welding parameters and surface condition. Avoid oxide scales or contaminations. Brushed or pickled welds perform better. The best results are obtained for solution annealed welds. The use of nickel based weld consumables allows to increase the corrosion resistance of welded structures (avoid 625 alloys but use Nb free grades like H.C22 or SG Ni Cr 23 Mo 16) or PHYWELD NCM (Nb free 625)

## MACHINING

CLI - SAF 2507 alloy can be machined with the same techniques than those used for austenitic stainless steels. High speed tools can be used while carbide tipped tools make it possible to increase substantially the speeds.

Turning requires generally lower speeds than for 304 grades. Drilling properties are better than with high corrosion resistant austenitic stainless steels.

Special melts with improved machinability properties are available on request. For more information, please consult us.

## DESIGN

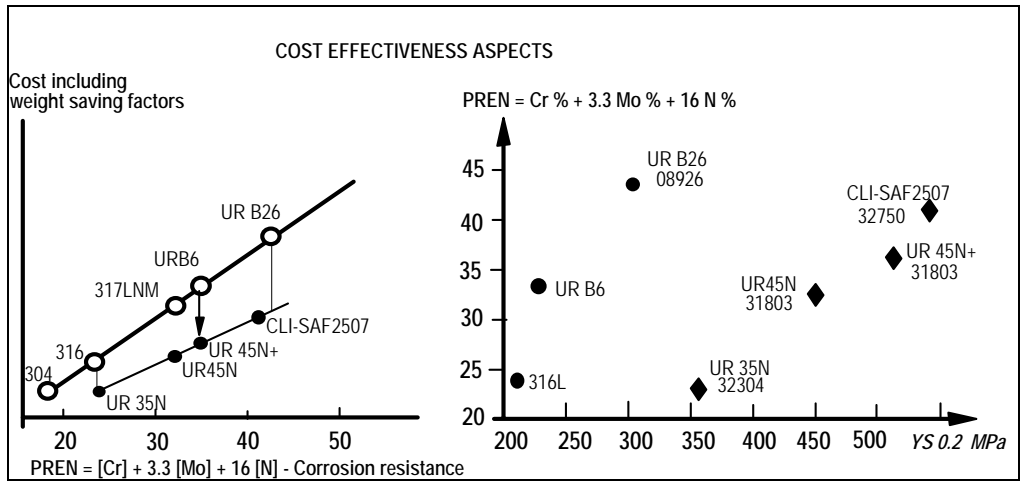
### Cost factor considerations

Maximum allowable stresses given by several pressure vessel codes are shown here. The high mechanical properties of CLI - SAF 2507 grade allow thickness and, consequently, cost reductions.

We are happy to offer assistance in evaluating potential cost savings related to pressure vessel or structural design and the excellent corrosion resistance properties of CLI - SAF 2507.

### Design stress values (Typical values)

Country	Code	Room temperature (MPa)				Saving factors URB6 /UR47N+
		316	UR 45N 31803	UR B6 904L	CLI-SAF2507 32750	
USA	ASME VIII, DIV1	108	115	123	190	35 %
F	CODAP 90, f.1	166	275	176	287	38 %
UK	BS 5500	128	289	173	294	42 %
D	ADW 2	128	300	167	327	49 %



## APPLICATIONS

- Seawater systems and applications (diving spheres...),
- Oil and gas Industry including sour gas applications,
- Petrochemical industry including PVC strippers,
- Pulp and paper industry (digesters, bleaching equipments...),
- Chemical industry including organic acid applications,
- Phosphoric acid plants,
- Truck-lorries multipurpose containers,
- ...

## SIZE RANGE

	Hot rolled plates	Cold rolled plates	Clad plates
Thickness	5 to 150 mm 3/16" to 6"	2 to 14 mm 5/64" to 5/8"	6 to 150 mm 1/4" to 6"
Width	Up to 3300 mm Up to 130"	Up to 2300 mm Up to 90.5"	Up to 3300 mm Up to 130"
Length	Up to 12000 mm Up to 472"	Up to 8250 mm Up to 325"	Up to 14000 mm Up to 551"

Other sizes are available on request, including 4100mm (161,5")width plates

#### NOTE

This technical data and information represents our best knowledge at the time of printing. However, it may be subject to some slight variations due to our ongoing research programme on corrosion resistant grades.

We therefore suggest that information be verified at time of enquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here is only for the purpose of description, and may only be considered as guarantees when our company has given written formal approval.

Further information may be obtained from the following address.

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