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Corus Engineering Steels

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# Untapped energy

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**Steels for the Oil and Gas Industry**



# Introduction

**With over 100 years in the business, our experience goes far beyond the confines of just steel manufacturing. We can advise on both material selection and supply routes, adding real value to a project from day one. Corus experts support design engineers across a wide variety of disciplines, helping our customers make the correct decision early in the design process.**

Special engineering steels are used throughout the oil and gas extraction industry for components where strength, toughness, resistance to fatigue and corrosion are paramount. Consistency and reliability are absolutely key. We not only provide steels that endure the extreme operating conditions that prevail in the oil and gas industry, we work in partnership with our customers to ensure that product performance is matched by sustainable and efficient supply.

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## Quality policy

Corus Engineering Steels is committed to the achievement of customer requirements and expectations and to continuous improvement in productivity, quality, service, costs and technology. The commitment is demonstrated by:

- the achievement of prescriptive quality assurance standards such as BSEN ISO 9001, ISO/TS 16949, SAE AS 9100, and company approvals within the market sectors which it serves
- the adoption of team working which serves to focus the attention of all employees on the quality of their work
- the development of an informed and motivated workforce with a positive commitment to professional excellence
- the setting of quantitative objectives whereby continuous improvements in performance against agreed goals can be readily measured
- the development of new and improved products designed to meet customer requirements
- the emphasis on prevention rather than detection in the drive to zero defects
- the assistance given to our customers and reaction to their concerns
- the optimum utilisation of facilities leading to 100% deliveries on time
- a reduction in process costs and increase in yields
- the development of suppliers and subcontractors

The relevant oil and gas industry approvals, and major approvals gained in other quality engineering sectors, include:

Alstom Energy  
 Baker Oil Tools  
 Boeing Commercial Airplane  
 British Aerospace  
 BS EN ISO 9001  
 Caterpillar  
 Det Norske Veritas  
 EN/AS 9100  
 GKN ADD  
 Halliburton  
 Lloyds RS  
 National Oilwell  
 QUASCO  
 Ramnas Bruck  
 Reed Tool Company  
 Rolls Royce  
 Schlumberger  
 Statoil  
 TS16949  
 T.U.V.  
 Weir Materials Limited

## Product range

Product		Metric (mm)	Imperial (in)
Primary Products			
Rolled	Blooms	211 - 457	8 <sup>1</sup> / <sub>4</sub> - 18
	Billets	50 - 211	2 - 8 <sup>1</sup> / <sub>4</sub>
	Slabs width thickness	100 - 500	3 <sup>7</sup> / <sub>8</sub> - 19 <sup>5</sup> / <sub>8</sub>
		50 - 330	2 - 12 <sup>15</sup> / <sub>16</sub>
Rounds	76 - 381	3 - 15	
Rerolled Products			
Lengths	Rounds	*25 - 105	1 - 4 <sup>1</sup> / <sub>8</sub>
	Hexagons	25 - 80	1 - 3 <sup>1</sup> / <sub>8</sub>
	Squares	25 - 48	1 - 1 <sup>7</sup> / <sub>8</sub>
Coils	Rounds	15.5 - 60	<sup>5</sup> / <sub>8</sub> - 2 <sup>5</sup> / <sub>16</sub>
	Hexagons	15 - 52	<sup>19</sup> / <sub>32</sub> - 2 <sup>1</sup> / <sub>16</sub>
	Squares	15 - 50	<sup>19</sup> / <sub>32</sub> - 2

Slab width and thickness combinations available on request.  
 Maximum turned bar size 350mm or 14in diameter.  
 Surface finish and heat treatment conditions as specified.  
 \* Smaller sizes by agreement.

Maximum product lengths are:

Supplied Condition	Primary		Rerolled	
	m	ft	m	ft
Rolled - Billets	13	42	18	59
Rolled - Other products	13	42	18	59
Turned	13	42	9	30
Heat Treated	10.4	34	9	30

# Carbon, chain and alloy steels

Grade	Related Standards & Specifications	Summary of Properties
<b>Carbon</b>		
LF2	ASTM A350	Standard carbon flange steel with good notch toughness
X65 Flange Steel	API 5LX ASTM A694	Higher strength, tough weldable carbon steel with good resistance to Hydrogen Induced Cracking
<b>Chain</b>		
R3	ORQ RQ3	Offshore mooring chain steel
ORQ +20%		Intermediate rig grade
R3S		Intermediate rig grade
R4	K4RIG, RQ4	High strength rig grade
<b>Alloy – Heat Treated</b>		
4130	API 6A NACE MR0175, ISO 15156 AISI 4130	Standard 0.3%C CrMo steel with good combination of strength and toughness
4140	API 6A NACE MR0175, ISO 15156 AISI 4140	Standard 0.4%C CrMo steel for use at higher strength levels
4140 Mod	NACE MR0175, ISO 15156	Enhanced hardenability version of 4140 for larger section sizes
4145H Mod	API7 sections 4/5/6	Enhanced hardenability version of 4145 for larger section sizes, suitable for drill collars
F22	ASTM A182, UNSK21590 NACE MR0175, ISO 15156	Weldable steel with good low temperature toughness
9Cr1Mo	ASTM A199 ASTM A213 NACE MR0175, ISO 15156	High strength alloy steel with corrosion resistance superior to the 41xx series
8630 Mod	NACE MR0175, ISO 15156	High strength alloy steel with good low temperature toughness
4340	ASTM A434	High strength alloy steel
4330V	AMS 6427, ASTM A646 AMS 4330M, UNS K23080	High strength, high toughness, low alloy steel for oil tool applications
EN30B	BS970 - 1955 835M30 - BS970 Pt11983	High strength alloy, combined with good impact properties
<b>Alloy Carburising</b>		
8620		Carburising steel
4715		Carburising steel
4815		Carburising steel
9310		Carburising steel

## Chemical analysis

Grade	Nominal Chemical Analysis %									
	C	Mn	Cr	Mo	Ni	V	Nb	Cu	N	
LF2	0.15	1.20	Optional V/Nb to customer requirements							
X65 Flange Steel	0.08	1.30								
R3	0.30	Alloyed for specific applications and sizes								
ORQ +20%	0.20									
R3S	0.20									
R4	0.25									
4130	0.30	0.50	1.00	0.20						
4140	0.40	0.80	1.00	0.20						
4140 Mod	0.40	1.00	1.00	0.33						
4145H Mod	0.47	1.10	1.10	0.33						
F22	0.12	0.50	2.40	1.00						
9Cr1Mo	0.12	0.50	9.00	1.00						
8630 Mod	0.30	0.85	0.95	0.40	0.85					
4340	0.40	0.70	0.80	0.25	1.80					
4330V	0.30	0.85	0.90	0.45	1.80	0.08				
EN30B	0.30	0.55	1.25	0.30	4.10					
8620	0.20	0.80	0.50	0.20	0.50					
4715	0.15	0.80	0.45	0.35	1.00					
4815	0.15	0.50		0.25	3.50					
9310	0.10	0.50	1.20	0.12	3.25					

# Carbon, chain and alloy steels

Grade	Related Standards & Specifications	Minimum Tensile Properties			
		UTS ksi (N/mm <sup>2</sup> )	0.2%PS ksi (N/mm <sup>2</sup> )	El %	R of A %
<b>Carbon</b>					
LF2	ASTM A350	70	36	22	30
X65	API 5LX	77	65		
Flange Steel	ASTM A694				

<b>Chain</b>					
R3	ORQ RQ3	100 (690)	60 (410)	17	50
ORQ +20%		110 (750)	80 (540)	15	50
R3S		113 (770)	71 (490)	15	50
R4	K4RIG, RQ4	125 (860)	85 (580)	12	50

## Alloy – Heat Treated

4130	API 6A	100	80	16	35
	NACE MR0175, ISO 15156	100	75	18	35
	AISI 4130				
4140	API 6A	130	110	13	35
	NACE MR0175, ISO 15156	120	100	14	30
	AISI 4140	100	80	20	40
4140 Mod	NACE MR0175, ISO 15156	130	110	13	35
		100	80	20	40
		100	70	20	40
4145H Mod	API7 sections 4/5/6	140	120	13	40
		135	110	13	40
F22	ASTM A182	100	75	18	35
	UNSK21590				
	NACE MR0175, ISO 15156				
9Cr1Mo	ASTM A199	100	80	20	40
	ASTM A213				
	NACE MR0175, ISO 15156				
8630 Mod	NACE MR0175, ISO 15156	100	85	15	35
		130	110	11	35
4340	ASTM A434	135 (930)	105 (720)	14	35
		130 (900)	100 (690)	14	35
4330V	AMS 6427, ASTM A646	130	115	16	50
	AMS 4330M	150	135	14	45
	UNS K23080	165	150	12	40
EN30B	BS970 1955	160	135	13	50
	835M30 - BS970 1983				

# Mechanical properties

Hardness (Max) HB	Limiting Ruling Section	Heat Treatment	Impact Properties Charpy 'V' Notch Joules @ Temperature	
197		By agreement	20 @ -46°C	
	6"	WQ & temper	50 @ -46°C	
	6"	WQ & temper	60 @ 0°C	
			40 @ -20°C	
	5"	WQ & temper	58 @ 0°C	
	6 1/2"	WQ & temper	65 @ 0°C	
			45 @ -20°C	
	5"	WQ & temper	50 @ -20°C	

235	2"	(N) WQ & temper		
	4"	(N) WQ & temper	20 @ -60°C	
341	6"	O/WQ & temper		
	7"	O/WQ & temper	40 @ 23°C	
	7"	O/WQ & temper	54 @ 23°C	
341	8"	O/WQ & temper		
	8"	O/WQ & temper	54 @ 23°C	
	11"	O/WQ & temper	54 @ 23°C	
341	6 7/8"	O/WQ & temper	54 @ 23°C	
	12 1/4"	O/WQ & temper	54 @ 23°C	
235	7"	WQ & temper	42 @ -60°C	
235	11"	OQ temper/ double temper	54 @ 23°C	
341	10"	(N) WQ & temper	42 @ -60°C	
	10"		27 @ -32°C	
	7"	O/WQ & temper		
	9 1/2"			
10"	10"	O/WQ & temper	88 @ 23°C	68 @ -46°C
			68 @ 23°C	41 @ -46°C
			54 @ 23°C	20 @ -46°C
			60 @ 23°C	20 @ -46°C

# Stainless steels

Grade	Related Standards & Specifications	Summary of Properties
Martensitic 410	ASTM A276 ASTM A479 NACE MR0175 ISO 15156	13%Cr steel with high strength and better corrosion resistance than alloy steels
420	ASTM A276	Lower ferrite 13%Cr steel for improved corrosion resistance and enhanced workability
F6NM Types*	UNS 42400 NACE MR0175 ISO 15156 ASTM A182	Enhanced 13%Cr steel with excellent low temperature impact properties and corrosion resistance
13/2/5	UNS S41427 X2CrNiMoV13-5-2 1.4415 NACE MR0175 ISO 15156	Enhanced 13%Cr steel with superior corrosion resistance, strength and toughness
Ppt Hardening 520B		Machinable corrosion resistant steel with freedom from distortion on heat treatment to high strengths
17/4	UNS S17400 ASTM A564 NACE MR0175 ISO 15156 W 1.4548	Improved corrosion resistant age-hardening stainless steel with minimal distortion and scaling on heat treating after machining
450	UNS S45000	Corrosion resistant age hardening steel
Austenitic** 304 304L	ASTM A182	Standard stainless steels for high corrosion resistance
316 316L 316LN	ASTM A182	Standard stainless steels for corrosion resistance higher than 304 types
Duplex 22/5*	ASTM A182 UNS S31803 NACE MR0175 ISO 15156	Higher strength/superior resistance to stress corrosion cracking for chloride and/or sour gas conditions
25/7*		Higher Cr duplex steel for improved pitting and corrosion resistance
Super Duplex*	UNS S32760	Enhanced strength and resistance to chloride stress corrosion cracking

\* Available on request \*\* Improved machinable versions (prefixed IM) are also available

# Chemical analysis

Grade	Nominal Chemical Analysis %								
	C	Mn	Cr	Mo	Ni	V	Nb	Cu	N
410	0.10	0.50	13.00						
420	0.20	0.80	13.00						
F6NM Types	0.02 0.02	0.70 0.70	13.00 13.00	0.35 0.55	4.00 4.00				
13/2/5	0.02	0.40	12.25	2.00	5.25	0.20			
520B	0.05	0.80	13.50	1.50	5.50		0.30	1.70	
17/4	0.05	0.80	16.00		4.00		0.30	3.50	
450	0.015	0.50	14.60	0.55	5.40		0.40	1.35	
304 304L	0.04 0.02	1.50 1.50	18.50 18.50		9.00 10.50				
316 316L 316LN	0.04 0.02 0.02	1.50 1.50 1.50	17.00 17.00 17.00	2.50 2.50 2.50	12.50 13.00 12.00				0.14
22/5	0.02	1.50	22.60	3.00	5.50				0.17
25/7	0.02	1.20	25.00	3.00	7.00				0.17
Super Duplex	0.02	0.50	25.50	3.50	7.00			0.70 +0.70%W	0.23

# Stainless steels

## Mechanical properties

Grade	Related Standards & Specifications	Minimum Tensile Properties				Hardness (Max) HB	Limiting Ruling Section	Heat Treatment (Condition)	Impact Properties Charpy 'V' Notch	
		UTS ksi	0.2%PS ksi	EI %	R of A %				Joules	@ Temperature
Martensitic 410	ASTM A276	100	80	20	40	235	10"	OQ & temper / double temper	20 @ -10°C	27 @ 0°C
	ASTM A479 NACE MR0175 ISO 15156									
420	ASTM A276	110	90	17	35	260	6"	OQ & temper / double temper	15 @ -10°C	
		100	80	20	40	235	10"			
F6NM Types*	UNS 42400	100	80	15	35	241	6"	Air hardened and double tempered	42 @ -60°C	
	NACE MR0175 ISO 15156 ASTM A182									
13/2/5	UNS S41427	105	95	18	40	28 HRc	OQ & temper stress relieved	54 @ -10°C	30 @ -60°C	
	X2CrNiMoV13-2-5 1.4415 NACE MR0175 ISO 15156	125	110	15	40	32 HRc		OQ & temper stress relieved	54 @ -10°C	30 @ -60°C
Ppt Hardening 520B	BS5S100	180	150	10				ST & aged	20 @ 23°C (IZOD)	
		160	150	12				ST & aged	27 @ 23°C (IZOD)	
17/4	UNS S17400 ASTM A564 NACE MR0175 ISO 15156 W 1.4548	135	110	15				ST & aged	54 @ 23°C (IZOD)	
		190	170	10	40	448	H900	ST & aged		
450	UNS S45000	135	105	16	50	352	H1150	ST & aged	41 @ 23°C	
		115	75	18	55	293	H1150M	ST & aged	74 @ 23°C	
		125	105	16	50	311	H1150D	ST & double aged	41 @ 23°C	
Austenitic** 304 304L	ASTM A182	125	75	18	55	294	H1150	OQ & aged	75 @ -60°C	
		75	30	30	50			ST & quenched		
316 316L 316LN	ASTM A182	70	25	30	50			ST & quenched		
		75	30	30	50			ST & quenched		
Duplex 22/5	ASTM A182 UNS S31803 NACE MR0175 ISO 15156	70	25	30	50			ST & quenched		
		75	30	30	50			ST & quenched		
25/7		90	65	25	45			ST & quenched		
Super Duplex	UNS S32760	100	70	25	45			ST & quenched		
		110	80	25				ST & quenched		

\* Available on request \*\* Improved machinable versions (prefixed IM) are also available

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