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# Untapped energy

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 approvals

The quality assurance procedures of Corus Engineering Steels have been assessed and approved by over 100 component and equipment manufacturers, end users and national bodies.

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  
 Civil Aviation Authority  
 Det Norske Veritas  
 EAQF 94  
 Ford Motor Company  
 GKN ADD  
 Halliburton  
 Lloyds RS  
 M.O.D.  
 Mobil  
 National Oilwell  
 QUASCO  
 Reed Tool Company  
 Rolls Royce  
 Scana Ramnas  
 Statoil  
 T.U.V.  
 Weir Materials Limited

## Product range

Product		Metric (mm)	Imperial (in)
Primary Products			
Rolled	Blooms	150 - 457	6 - 18
	Billets	50 - 228	2 - 9
	Gothics (A/C)	111 - 362	4 <sup>7</sup> / <sub>16</sub> - 14 <sup>1</sup> / <sub>2</sub>
	Slabs	76 - 1054	3 - 41 <sup>1</sup> / <sub>2</sub>
	width	44 - 317	1 <sup>3</sup> / <sub>4</sub> - 12 <sup>1</sup> / <sub>2</sub>
	thickness	76 - 381	3 - 15
Cast	Rounds	140 - 180	
	Squares	125, 140, 155, 160, 175 & 200	
	Rounds		
Rerolled Products			
Lengths	Rounds	15.5 - 115	5 <sup>5</sup> / <sub>8</sub> - 4 <sup>1</sup> / <sub>2</sub>
	Hexagons	19 - 81.5	3 <sup>3</sup> / <sub>4</sub> - 3 <sup>3</sup> / <sub>16</sub>
	Squares	18 - 103	1 <sup>11</sup> / <sub>16</sub> - 4 <sup>1</sup> / <sub>8</sub>
Coils	Rounds	13.5 - 42	1 <sup>7</sup> / <sub>32</sub> - 1 <sup>21</sup> / <sub>32</sub>
	Hexagons	13.5 - 33.5	1 <sup>7</sup> / <sub>32</sub> - 1 <sup>9</sup> / <sub>16</sub>
	Squares	14 - 24	9 <sup>1</sup> / <sub>16</sub> - 1 <sup>5</sup> / <sub>16</sub>

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

Maximum product lengths are:

Supplied Condition	Primary		Rerolled	
	m	ft	m	ft
Cast	18	59	Not applicable	
Rolled - Billets <180mm	15	49	Not applicable	
Rolled - Other products	13.1	43	18	59
Turned	13.1	43	8.5	28
Heat Treated	10.4	34	8.5	28

# 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	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
R4 Special	K4RIG LC	High strength, large section low carbon, rig grade
<b>Alloy</b>		
4130	API 6A Type 2 NACE MR0175 AISI 4130	Standard 0.3%C CrMo steel with good combination of strength and toughness
4140	API 6A Type 2 NACE MR0175 AISI 4140	Standard 0.4%C CrMo steel for use at higher strength levels
4140 Mod	NACE MR0175	Enhanced hardenability version of 4140 for larger section sizes
4145	API7 sections 4/5/6 AISI 4145	Standard 0.45%C CrMo steel for high strength in medium sections
4145 Mod	API7 sections 4/5/6	Enhanced hardenability version of 4145 for larger section sizes, suitable for drill collars
9Cr1Mo	ASTM A199 ASTM A213 NACE MR0175	High strength alloy steel with corrosion resistance superior to the 41xx series
Double Tough	AMS 6424	High strength, high toughness, low alloy steel for oil tool applications

# 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									
R4 Special	0.05									
4130	0.30	0.50	1.00	0.20						
4140	0.40	0.80	1.00	0.20						
4140 Mod	0.40	0.80	1.00	0.33						
4145	0.45	0.90	1.00	0.20						
4145 Mod	0.47	1.10	1.10	0.33						
9Cr1Mo	0.12	0.50	9.00	1.00						
Double Tough	0.30	0.85	0.90	0.45	1.80	0.08				

# Carbon, chain and alloy steels

## Mechanical properties

Grade	Related Standards & Specifications	Minimum Tensile Properties				Hardness (Max) HB	Limiting Ruling Section	Heat Treatment	Impact Properties Charpy 'V' Notch	
		UTS ksi (N/mm <sup>2</sup> )	0.2%PS ksi (N/mm <sup>2</sup> )	El %	R of A %				Joules	Temperature
<b>Carbon</b>										
LF2	ASTM A350	70	36	22	30	197		By agreement	20	-50°F
X65 Flange Steel	API 5LX	77	65				6"	WQ & temper	50	-50°F
<b>Chain</b>										
R3	ORQ RQ3	100 (690)	60 (410)	17	50		6"	WQ & temper	60 40	0°C -20°C
ORQ +20%		110 (750)	80 (540)	15	50		5"	WQ & temper	58	0°C
R3S		113 (770)	71 (490)	15	50		6 1/2"	WQ & temper	65 45	0°C 20°C
R4	K4RIG, RQ4	125 (860)	85 (580)	12	50		5"	WQ & temper	50	-20°C
R4 Special	K4RIG LC	125 (860)	85 (580)	12	50		6 1/4"	WQ & temper	50	-20°C
<b>Alloy</b>										
4130	API 6A Type 2 NACE MR0175 AISI 4130	100 90	80 80	16 18	35 35	235 235	2" 12 1/4"	WQ & temper WQ & temper	20	-75°F
4140	API 6A Type 2 NACE MR0175 AISI 4140	140 120 100	110 100 80	14 14 20	35 30 40	341 302 235	3" 7" 7"	O/WQ & temper O/WQ & temper O/WQ & temper	40 54	23°C 23°C
4140 Mod	NACE MR0175	100 100	80 80	20 20	40 40	235	10" 14 3/8"	O/WQ & temper	54	23°C
4145	API7 sections 4/5/6 AISI 4145	140	110	13	40	341	6 1/2"	O/WQ & temper	54	23°C
4145 Mod	API7 sections 4/5/6	140 135	120 110	13 13	40 40	341 341	6 7/8" 12 1/4"	O/WQ & temper O/WQ & temper	54 54	23°C 23°C
9Cr1Mo	ASTM A199 ASTM A213 NACE MR0175	100	80	20	40	235	11"	OQ & double temper	54	23°C
Double Tough	AMS 6424	155	140	19	58		8"	O/WQ & temper	80	-50°F

# Stainless steels

Grade	Related Standards & Specifications	Summary of Properties
Martensitic 410	ASTM A276 ASTM A479 NACE MR0175	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 ASTM A182	Enhanced 13%Cr steel with excellent low temperature impact properties and corrosion resistance
13/2/5		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 W 1.4548	Improved corrosion resistant age-hardening stainless steel with minimal distortion and scaling on heat treating after machining
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	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

\* 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	0.70	13.00	0.35	4.00					
13/2/5	0.02	0.70	13.00	0.55	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		
304	0.04	1.50	18.50		9.00					
304L	0.02	1.50	18.50		10.50					
316	0.04	1.50	17.00	2.50	12.50					
316L	0.02	1.50	17.00	2.50	13.00					
316LN	0.02	1.50	17.00	2.50	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	0.23 +0.70%W	

# Stainless steels

## Mechanical properties

Grade	Related Standards & Specifications	Minimum Tensile Properties				Hardness (Max) HB	Limiting Ruling Section	Heat Treatment	Impact Properties Charpy 'V' Notch	
		UTS ksi	0.2%PS ksi	EI %	R of A %				Joules	Temperature
Martensitic 410	ASTM A276 ASTM A479 NACE MR0175	100	80	20	40	235	10"	OO & temper	20	-10°C
		27	0°C							
420	ASTM A276	110	90	17	35	260 241	6" 6"	OO & temper / double temper	15	-10°C
		100	85	20	40					
F6NM Types	UNS 42400 NACE MR0175 ASTM A182	100	80	15	35	241	6"	Air hardened and double tempered	42	-60°C
13/2/5		130	95	24	64			OO & temper	180	-10°C
		135	110	22	60				160	-10°C
Ppt Hardening 520B		180	150	10				ST & aged	20	IZOD @ 23°C
		160	150	12					27	
		135	110	15					54	
17/4 (Cond) H900 H1150 H1150M	UNS S17400 ASTM A564 NACE MR0175 W 1.4548	190	170	10	40	448		ST & aged		
		135	105	16	50	352		ST & aged	41	23°C
		115	75	18	55	293		ST & aged	74	23°C
Austenitic* 304 304L 316 316L 316LN	ASTM A182	75	30	30	50			ST & quenched		
		70	25	30	50				ST & quenched	
	ASTM A182	75	30	30	50			ST & quenched		
		70	25	30	50			ST & quenched		
		75	30	30	50			ST & quenched		
Duplex 22/5	ASTM A182 UNS S31803 NACE MR0175	90	65	25	45			ST & quenched		
25/7		100	70	25	45			ST & quenched		
Super Duplex	UNS S32760	110	80	25				ST & quenched		

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

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