

ROLLED PRODUCTS FOR SHIPBUILDING

Basic indices for shipbuilding rolled products

Name of agency	Shop	Process. Status of product when delivered	Steel Grade	Shape (thickness mm)	
Lloyd's Register	Hot-strip Mill 2	BOF - Electric Furnace - Concasing Machines – Hot-Rolled Product	A, B	Up to 12	
			A, B, D, E		
			AH27S, AH32, AH36, DH27S,DH32,DH36		
			AH27S, AH32, DH27S, DH32, EH27S, EH32		
			360FG, 410FG, 460FG, 490FG, 510FG		
			360FG, 410FG, 460FG, 490FG		
	Hot-strip Mill 1	BOF - (Electric Furnace Ingot Casting) – Concasing Machines - Hot-Rolled Product	A, B (and with Z-properties)	Up to 12	
			BOF - (Electric Furnace - Ingot Casting) – Concasing Machines - Normalizing	A, B, D, E (and with Z-properties)	Up to 40
			A (and with Z-properties)	Up to 32	
	Hot-strip Mill 3	BOF - Continuous Casting Machines – Thermomechanical rolling+Accelerated cooling	A, B (and with Z-properties)	Up to 70	
			AH27S, DH27S, EH27S, AH32, DH32, EH32, AH36, DH36, EH36, AH40, DH40, EH40 (and with Z-properties)	Up to 50	
			AH27s, Dh27s, Eh27s, AH32, Dh32, Eh32, AH36, Dh36, Eh36, AH40, Dh40, Eh40 (and with Z-properties)	Up to 70	
			AH40, DH40, EH40 (and with Z-properties)	Up to 40	
	ABS (American Bureau of Shipping)	Hot-strip Mill 1	BOF - Continuous Casting Machines – Normalizing	A, B	Up to 51
			Open-Hearth Furnaces – Ingot - Normalizing	A, B, D	Up to 45
Electric furnaces - Continuous Casting Machines - Hot-Rolled Product			A, B, D	Up to 13	
BOF - Continuous Casting Machines - Hot-Rolled Product			A, B, D	Up to 16	
Electric furnace - Continuous Casting Machines - Normalizing			A, B, D	Up to 32	
BOF - Continuous Casting Machines - Normalizing			AH32, Dh32	Up to 40	
Electric furnace - Continuous Casting Machines - Normalizing			AH32, Dh32	Up To 32	
Hot-strip Mill 2		BOF - Continuous Casting Machines - Hot-Rolled Product	A, B, D	Up to 12	
AH32, DH32					
AH32, AH36, DH32, DH36					

		BOF - Continuous Casting Machines - Controlled (Normalizing) rolling	Ah40, Dh40, Eh40	5-12
	Hot-strip Mill 3	BOF - Continuous Casting Machines - Thermomechanical controlled rolling	Dh32,Dh36,Dh40, Eh32, Eh36,Eh40	Up to 50
			AH32, AH36, AH40	Up to 70
		BOF - Continuous Casting Machines - Thermomechanical controlled rolling with accelerated cooling	A, B	Up to 70
Det Norske Veritas)	Hot-strip Mill 1	BOF(Electric furnace) - Continuous Casting Machines - Normalizing	A, B (and with Z-properties)	Up to 40 (32)
		BOF(Electric furnace) - Continuous Casting Machines - Normalizing	D, E, A27s, D27s, A32, D32, E32 (and with Z-properties)	Up to 40 (32)
		BOF – Continuous Casting Machines - Normalizing or Hardening+Tempering	A36, D36, E36 (and with Z-properties)	Up to 40
		Electric Furnace – Continuous Casting Machines - Normalizing or (Hardening+Tempering)	A36, D36, E36 (and with Z-properties)	Up to 32 (30)
		BOF(Electric furnace) - Continuous Casting Machines - Hardening+Tempering	A40, D40, E40 (and with Z-properties)	Up to (30)
	Hot-strip Mill 2	BOF - Continuous Casting Machines - Hot-Rolled Product	A, B, D, A32, D32	Up to 12
		BOF – Continuous Casting Machines – Thermomechanical controlled rolling	E32, A36, D36, E36, A40, D40, E40	Up to 12
	Det Norske Veritas	Hot-strip Mill 3	BOF – Electric furnace-Continuous Casting Machines – Thermomechanical rolling	A, B (and with Z-properties)
BOF(Electric Furnace) - Continuous Casting Machines - Thermomechanical rolling			A32, D32, E32, A36, D36, E36	Up to 16 (25)
BOF - Continuous Casting Machines - Thermomechanical rolling			A32, A36, A40, D32, D36, D40 (and with Z-properties)	Up to 70
German Lloyd's Register	Hot-strip Mill	BOF(Electric furnace) - Continuous Casting Machines - Normalizing	A, B, D	Up to 40 (32)
		BOF(Electric furnace) – Continuous Casting Machines – Normalizing	A32, D32, A36, D36	Up to 40 (32)
		BOF(Electric Furnace) - Continuous Casting Machines – Hardening+Tempering	A36, D36, E36, A40, D40, E40 (and with Z-properties)	Up to 40 (30)
	Hot-strp mill 2	BOF - Continuous Casting Machines – Hot-Rolled Product	A, B, D	Up to 12
		BOF - Continuous Casting Machines – Hot-Rolled Product	A32, D32, A36, D36, A40, D40	Up to 12
	Hot-strp mill 3	BOF - Electric Furnace Shop-Continuous Casting Machines – Thermomechanical rolling with accelerated cooling	A, B	13-70

		BOF - Continuous Casting Machines – Thermomechanical rolling with accelerated cooling	A32, D32, E32, A36, D36, E36, A40, D40, E40 (and with Z-properties)	13-70
BV (Bureau Veritas)	Hot-strp mill 1	BOF(Electric furnace) – Continuous Casting Machines - Normalizing	A, B, D, E	Up to 40 (32)
	Hot-strp mill 2	BOF - Electric Furnace – Continuous Casting Machines - Hot-Rolled Product	A, B, D	Up to 12
	Hot-strp mill 2	BOF - Electric Furnace – Continuous Casting Machines - Hot-Rolled Product	Ah32, Dh32	Up to 12
		BOF - Electric Furnace – Continuous Casting Machines - Hot-Rolled Product	Ah36, Dh36	Up to 12
	Hot-strp mill 1	BOF(Electric Furnace Shop) - Continuous Casting Machines - Normalizing	Ah32, Dh32, Eh32, Ah36, Dh36, Eh36 (and with Z-properties)	Up to 40 (32)
		BOF(Electric Furnace) - Continuous Casting Machines - Hardening+Tempering	Ah40, Dh40, Eh40 (and with Z-properties)	Up to 40 (32)
	Hot-strp mill 3	BOF - Electric Furnace – Continuous Casting Machines - Thermomechanical rolling with accelerated cooling	A, B	Up to
Register of Shipping of the Russian Federation	Hot-strp mill 1	Electric furnace - Continuous Casting Machines - Any	A, B	Up to 12
		Electric furnace - Continuous Casting Machines - Normalizing	A, B	Up to 32
		Electric furnace – Continuous Casting Machines - Normalizing	D	Up to 25
		Electric furnace – Continuous Casting Machines - Normalizing	A32, D32, E32, A36, D36, E36 (and with Z-properties)	Up to 25
		Electric furnace -Continuous Casting Machines - Hardening+Tempering	A32, D32, E32, A36, D36, E36 (and with Z-properties)	Up to 32
		Electric furnace -Continuous Casting Machines - Hardening+Tempering	A40, D40, E40 (and with Z-properties)	Up to 32
		Electric furnace -Continuous Casting Machines - Hardening+Tempering	F36, F40	Up to 32
		BOF - Continuous Casting Machines – Any	A, B	Up to 12
		BOF - Continuous Casting Machines – Normalizing	A, B	Up To 50
		BOF - Continuous Casting Machines – Normalizing	D	Up to 40
		BOF - Continuous Casting Machines – Normalizing	A32 ,D32, E32, A36, D36, E36 (and with Z-properties)	Up to 40
		BOF - Continuous Casting Machines – Hardening+Tempering	D32, E32, D36, E36 (and with Z-properties)	Up to 40
		BOF - Continuous Casting Machines – Hardening+Tempering	A40, D40, E40 (and with Z-properties)	Up to 40

	Hot-strip mill 1	BOF - Electric Furnace Shop - Continuous Casting Machines - Normalizing or Hardening+Tempering	A32cb, D32cb, E32cb, A36cb, D36cb, E36cb (and with Z-properties)	Up to 40	
		BOF -Electric Furnace Shop - Continuous Casting Machines-Normalizing or Hardening+Tempering	A32w, D32w, E32w, A36w, D36w, E36w	Up to 40	
	Hot-strip mill 2	BOF - Continuous Casting Machines – Any	A, B, D, E	Up to 12	
		BOF - Continuous Casting Machines – Any	A32, D32, E32, A36, D36, E36, A40	Up to 12	
		BOF - Continuous Casting Machines – Normalizing rolling	D40, E40	Up to 12	
	Hot-strip mill 3	BOF - Electric furnace - Continuous Casting Machines - Thermomechanical rolling	A, B	Up to 70	
		BOF-Electric furnace-Continuous Casting Machines-Thermomechanical rolling	D	Up to 50	
	Register of Shipping of the Russian Federation	Hot-strp mill 3	BOF - Electric furnace-Continuous Casting Machines – Thermomechanical rolling	E	Up to 25
			BOF - Electric furnace - Continuous Casting Machines - Thermomechanical rolling	A32, D32, E32, A36, D36, E36 (and with Z-properties)	Up to 70
			BOF - Electric furnace - Continuous Casting Machines – Thermomechanical rolling or Hardening + Tempering	A40	Up to 70
BOF - Electric furnace - Continuous Casting Machines – Thermomechanical rolling or Hardening + Tempering			D40	Up To 50	
BOF - Electric furnac - Continuous Casting Machines – Thermomechanical rolling			A32cb, D32cb, E32cb, A36cb, D36cb, E36cb (and with Z-properties)	Up to 40	
Section Rolling Shop		BOF - Electric furnace - Continuous Casting Machines - Thermomechanical rolling	A32w, D32w, E32w, A36w, D36w, E36w	Up to 40	
		Rolling mill 250 (350)	A, B	Steel angle	
River Shipping Register of the Russian Federation	Hot-strp mill 1	BOF - Electric furnace - Continuous Casting Machines - Hot-rolled product	A, B	Up to 12	
		BOF - Continuous Casting Machines – Normalizing	A, B, D, E	Up to 40	
		Electric Furnace - Continuous Casting Machines - Normalizing	A,B,D,E	Up to 32	
		BOF - Continuous Casting Machines – Normalizing	A32, D32, E32, A36, D36	Up to 40	
		Electric Furnace - Continuous Casting Machines - Normalizing	A32, D32, E32, A36, D36	Up to 32	
	Hot-strp mill 2	BOF - Continuous Casting Machines - Hot-rolled product	A, B, D, E	Up to 12	

BOF - Continuous Casting Machines - Hot-rolled product	A32, D32	Up to 12
BOF - Continuous Casting Machines - Hot-rolled product	A32, D32, E32, A36, D36	Up to 12

Sheet/Plate gauge tolerances

Thickness, mm	Maximal plus deviations from sheet thickness at width, mm					
	Up to 1200, incl.	Over 1200 up to 1500, incl.	Over 1500 up to 1800, incl.	Over 1800 up to 2100, incl.	Over 2100 up to 2400, incl.	Over 2400 up to 2700, incl.
4.0-11.0	0.8	0.8	0.8	0.8	0.8	0.8
11.5-12.0	0.8	0.8	0.8	0.8	0.8	0.9
12.5-16.0	0.8	0.8	0.8	0.8	0.9	0.9
16.5-20.0	0.8	0.8	0.8	0.8	0.9	1.0
21.0-22.0	0.8	0.9	0.9	0.9	1.0	1.1
23.0-25.0	0.9	0.9	1.0	1.0	1.0	1.2
26.0-28.0	1.0	1.0	1.1	1.1	1.1	1.3
29.0-30.0	1.1	1.1	1.2	1.2	1.2	1.4
31.0-32.0	1.2	1.2	1.3	1.3	1.3	1.5
33.0-35.0	1.3	1.3	1.4	1.4	1.4	1.6
36.0-38.0	1.4	1.4	1.5	1.5	1.5	1.7
39.0-40.0	1.5	1.5	1.6	1.6	1.6	1.8
41.0-45.0	1.6	1.6	1.7	1.8	1.7	2.0
46.0-50.0	1.8	1.8	1.8	2.0	1.8	2.3

Chemical composition

Standard (Specifications)	Steel Grade	Fraction of total mass, %												
		C	Mn	Si	P max	S max	Cr	Ni	Cu	Mo	Al	Nb	V	Ti
TU 14-105-584-95	A	0.21 max	0.55	0.50 Max	0.040	0.040	0.3 Max	0.3 Max	0.30 max	-	-	-	-	-
	B	0.21 max	0.80	0.35 Max	0.040	0.040	0.3 Max	0.3 Max	0.30 max	-	0.06	-	-	-
	D	0.21 max	0.60	0.35 Max	0.040	0.040	0.3 Max	0.3 Max	0.30 max	-	0.015-0.060	-	-	-
	E	0.18 max	0.70	0.35 Max	0.040	0.040	0.3 Max	0.3 Max	0.30 max	-	0.015-0.060	-	-	-
	A32, D32, E32, A36, D36, E36, A40, D40, E40	0.18 max	0.90-1.60	0.50 Max	0.035	0.035	0.2 max	0.4 max	0.35 max	0.08 max	0.015-0.060	0.02-0.05	0.05-0.10	0.02
TU 5.961-11632-97	A32Z	0.13	1.2	0.15							0.015			
	D32Z	-	-	-	0.012	0.008	0.2 max	0.4 max	0.35 max	0.08 max	-	-	-	0.02
	E32Z	0.17	1.6	0.50							0.060			
	A36Z	0.13	1.2	0.15							0.015	0.02	0.05	
	D36Z	-	-	-	0.012	0.008	0.2 max	0.4 max	0.35 max	0.08 max	-	-	-	0.02
	E36Z	0.17	1.6	0.50							0.060	0.060	0.10	
Lloyd's Register of Shipping, American Bureau of Shipping, Det Norske Veritas	A	0.23 max	(2.5-C) max	0.50 max	0.040	0.040								
	B	0.21 max	0.80 max	0.50 max	0.040	0.040								
	D	0.21 max	0.60 max	0.10-0.50	0.040	0.040								
	E	0.18 max	0.70 max	0.10-0.50	0.040	0.040								

Mechanical properties

Steel Grade	Mechanical properties at tension			Impact bending test		
	Ultimate strength, Rm, MPa	Yield Strength, Ren, MPa	Relative elongation δ_5 , %, min	Thickness, mm	Test temperature, °C	Impact work, KV, J, min
A, B, C, D	400-490	235	22	5.5-7.0	-40	19
				7.5-9.5	-20	24
				10 and over	0	27
A32, D32, E32	440-590	315	22	5.5-7.0	-40	22
				7.5-9.5	-20	26
				10 and over	0	31
A36, D36, E36	490-620	355	21	5.5-7.0	-40	24
				7.5-9.5	-20	28
				10 and over	0	34
A40, D40, E40	510-650	390	20	5.5-7.0	-40	27
				7.5-9.5	-20	34
				10 and over	0	41

Mechanical properties

Steel Grade	Ultimate strength, Rm, MPa	Yield Strength, Ren, MPa	Relative elongation δ_5 , %, min	Reduction of area, Ψ , %	Impact bending test	
					Test temperature, °C	Impact work, KV, J, min
A32Z, D32Z, E32Z	440-590	315	22	25	-40	31
					-20	
					0	
A36Z, D36Z, E36Z	490-620	355	21	25	-40	34
					-20	
					0	

According to ASTM A131/131M

Rolled products from structural steel are used in shipbuilding industry. Production of steel grades A and B has been brought to a commercial level. Same is applicable to other grades of steel, when agreed upon with a customer.