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Desde 1982

MATERIALS FOR FLANGES MANUFACTURING

STEEL FORGINGS FOR THE FITTINGS INDUSTRY

ASME/ASTM SA-105/SA-105M-05
Carbon Steel Forgings for Piping Applications

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	Tensile Strength MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Hardness HB	Heat Treatment
	K03504	≤0,35	0,60-1,05	≤0,035	≤0,040	0,10-0,35	≤0,40	≤0,30	≤0,12	≥485	≥250	≥30	≥30	≤187	A, N, NT, QT
		Other elements Cu ≤0,40 V ≤0,08													

ASME/ASTM SA-181/SA-181M-06
Carbon Steel Forgings for General Purpose Piping

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	Tensile Strength MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Hardness HB	Heat Treatment
Class 60	K03502	≤0,35	≤1,10	≤0,05	≤0,05	0,10-0,35	—	—	—	≥415	≥205	≥22	≥35	—	—
Class 70										≥485	≥250	≥18	≥24	—	—

ASTM SA-694/SA-694M-03
Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service

Grade	UNS	C	Mn	P	S	Si		Tensile Strength MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Hardness HB	Heat Treatment
F42								≥415	≥290	≥20	—	—	N, NT, QT
F46								≥415	≥315	≥20	—	—	N, NT, QT
F48								≥425	≥330	≥20	—	—	N, NT, QT
F50		≤0,26	≤1,40	≤0,025	≤0,025	0,15-0,35	HEAT ANALYSIS	≥440	≥345	≥20	—	—	N, NT, QT
F52								≥455	≥360	≥20	—	—	N, NT, QT
F56		≤0,30	≤1,50	≤0,030	≤0,030	0,13-0,37	PRODUCT ANALYSIS	≥470	≥385	≥20	—	—	N, NT, QT
F60								≥515	≥415	≥20	—	—	N, NT, QT
F65								≥530	≥450	≥20	—	—	N, NT, QT
F70								≥565	≥485	≥18	—	—	N, NT, QT

ASME/ASTM SA-727/SA-727M-02(07)
Carbon Steel Forgings for Piping Components with Inherent Notch Toughness

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	Tensile Strength MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Hardness HB	Heat Treatment
HEAT ANALYSIS		≤0,25	0,90-1,35	≤0,035	≤0,025	0,15-0,30	≤0,40	≤0,30	≤0,12	415-585	≥250	≥22	≥30	—	N, NT, QT
PRODUCT ANALYSIS		≤0,28	0,84-1,41	≤0,043	≤0,033	0,13-0,32	≤0,43	≤0,34	≤0,13						
		Cu	Cb	V											
HEAT ANALYSIS		≤0,40	≤0,02	≤0,05	(Cu + Ni +Cr+ Mo) ≤ 1,00%; (Cr + Mo) ≤ 0,32% ON HEAT ANALYSIS										
PRODUCT ANALYSIS		≤0,43	≤0,03	≤0,055											

Heat Treatments: A Annealing, N Normalizing, NT Normalizing and Tempering, QT Quenching and Tempering

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ASME/ASTM SA-182/SA-182M-07

Martensitic Stainless Steels.

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	Tensile Strength MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Hardness HB	Heat Treatment
F6a Class 1	S41000	≤0,15	≤1,00	≤0,040	≤0,030	≤1,00	≤0,50	11,5-13,5	—	≥485	≥275	≥18	≥35	143-207	A, NT, T
F6a Class 2	S41000	≤0,15	≤1,00	≤0,040	≤0,030	≤1,00	≤0,50	11,5-13,5	—	≥585	≥380	≥18	≥35	167-229	A, NT, T
F6a Class 3	S41000	≤0,15	≤1,00	≤0,040	≤0,030	≤1,00	≤0,50	11,5-13,5	—	≥760	≥585	≥15	≥35	235-302	A, NT
F6a Class 4	S41000	≤0,15	≤1,00	≤0,040	≤0,030	≤1,00	≤0,50	11,5-13,5	—	≥895	≥760	≥12	≥35	263-321	A, NT
F6b	S41026	≤0,15	≤1,00	≤0,020	≤0,020	≤1,00	1,00÷-2,00	11,5-13,5	0,40-0,60	760-930	≥620	≥16	≥45	235-285	A, NT
		Other elements Cu≤0,50													
F6NM	S41500	≤0,05	0,50-1,00	≤0,030	≤0,030	≤0,60	3,5-5,5	11,5-14,0	0,50-1,00	≥790	≥620	≥15	≥45	≤295	NT

Ferritic Stainless Steels

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	Tensile Strength MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Hardness HB	Heat Treatment
FXM-27Cb	S44627	≤0,010	≤0.40	≤0,020	≤0,020	≤0,40	≤0,50	25,0-27,5	0,75-1,50	≥415	≥240	≥20	≥45	≤190	A
		Other elements Cb 0,05-0,20 N ≤0,015 Cu ≤0,20 (Ni + Cu) ≤ 0,50													
F429	S42900	≤0,12	≤1.00	≤0,040	≤0,030	≤0,75	≤0,50	14,0-16,0	—	≥415	≥240	≥20	≥45	≤190	A
F430	S43000	≤0,12	≤1.00	≤0,040	≤0,030	≤0,75	≤0,50	16,0-18,0	—	≥415	≥240	≥20	≥45	≤190	A

Heat Treatments: A Annealing, N Normalizing,, T Tempering, NT Normalizing and Tempering

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ASME/ASTM SA-182/SA-182M-07

Low Alloy Steels for High Temperature Service

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	Tensile Strength MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Hardness HB	Heat Treatment
F1	K12822	≤0,28	0,60-0,90	≤0,045	≤0,045	0,15-0,35	---	---	0,44-0,65	≥485	≥275	≥20	≥30	143-192	A, NT
F2	K12122	0,05-0,21	0,30-0,80	≤0,40	≤0,40	0,10-0,60	---	0,50-0,81	0,44-0,65	≥485	≥275	≥20	≥30	143-192	A, NT
F5	K41545	≤0,15	0,30-0,60	≤0,030	≤0,030	≤0,50	≤0,50	4,0-6,0	0,44-0,65	≥485	≥275	≥20	≥35	143-217	A, NT
F5a	K42544	≤0,25	≤0,60	≤0,40	≤0,030	≤0,50	≤0,50	4,0-6,0	0,44-0,65	≥620	≥450	≥22	≥50	187-248	A, NT
F9	K90941	≤0,15	0,30-0,60	≤0,030	≤0,030	0,50-1,00	---	8,0-10,0	0,90-1,10	≥585	≥380	≥20	≥40	179-217	A, NT
F10	S33100	0,10-0,20	0,50-0,80	≤0,040	≤0,030	1,00-1,40	19,0-22,0	7,0-9,0	---	≥550	≥205	≥30	≥50	---	SQ
F91	K90901	0,08-0,12	0,30-0,60	≤0,020	≤0,010	0,20-0,50	≤0,40	8,0-9,5	0,85-1,05	≥585	≥415	≥20	≥40	≤248	NT
		Other elements Cb 0,06-0,10 N 0,03-0,07 Al< 0,02 V 0,18-0,25 Ti <0,01 Zr< 0,01													
F92	K92460	0,07-0,13	0,30-0,60	≤0,020	≤0,010	≤0,50	≤0,40	8,50-9,50	0,30-0,60	≥620	≥440	≥20	≥45	≤269	NT
		Other elements Cb 0,04-0,09 V 0,15-0,25 N 0,030-0,070 Al < 0,02 W 1,50-2,00 B 0,001-0,006													
F122	K91271	0,07-0,14	≤0,7	≤0,020	≤0,010	≤0,50	≤0,50	10,00-11,50	0,25-0,60	≥620	≥400	≥20	≥40	≤250	NT
		Other elements Cb 0,04-0,10 V 0,15-0,30 B ≤0,005 N 0,0040-0,100 Al ≤0,02 Cu 0,30-1,70													
		W 1,50-2,50 Ti ≤0,01 Zr ≤0,01													
F911	K91061	0,09-0,13	0,30-0,60	≤0,020	≤0,010	0,10-0,50	≤0,40	8,5-9,5	0,90-1,10	≥620	≥440	≥18	≥40	187-248	NT
		Other elements Cb 0,060-0,10 W 0,90-1,10 Al ≤0,02 N 0,04-0,09 V 0,18-0,25 B 0,0003-0,006													
		Ti ≤0,01 Zr ≤0,01													
F11 Class 1	K11597	0,05-0,15	0,30-0,60	≤0,030	≤0,030	0,50-1,00	---	1,00-1,50	0,44-0,65	≥415	≥205	≥20	≥45	121-174	A, NT
F11 Class 2	K11572	0,10-0,20	0,30-0,80	≤0,040	≤0,040	0,50-1,00	---	1,00-1,50	0,44-0,85	≥485	≥275	≥20	≥30	143-207	A, NT
F11 Class 3	K11572	0,10-0,20	0,30-0,80	≤0,040	≤0,040	0,50-1,00	---	1,00-1,50	0,44-0,65	≥515	≥310	≥20	≥30	156-207	A, NT
F12 Class 1	K11562	0,05-0,15	0,30-0,60	≤0,045	≤0,045	0,50MAX	---	0,80-1,25	0,44-0,65	≥415	≥220	≥20	≥45	121-174	A, NT
F12 Class 2	K11564	0,10-0,20	0,30-0,80	≤0,040	≤0,040	0,10-0,60	---	0,80-1,25	0,44-0,65	≥485	≥275	≥20	≥30	143-207	A, NT
F21	K31545	0,05-0,15	0,30-0,60	≤0,040	≤0,040	≤0,50	---	2,7-3,3	0,80-1,06	≥515	≥310	≥20	≥30	156-207	A, NT
F3V	K31830	0,05-0,18	0,30-0,60	≤0,020	≤0,020	≤0,10	---	2,8-3,2	0,90-1,10	585-760	≥415	≥18	≥45	174-237	A, NT
		Other elements Ti 0,015-0,035 V 0,20-0,30 B 0,001-0,003													
F3VCb	K31390	0,10-0,15	0,30-0,60	≤0,020	≤0,040	≤0,10	≤0,25	2,7-3,3	0,90-1,10	585-760	≥415	≥18	≥45	174-237	A, NT
		Other elements Cb 0,015-0,07 V 0,20-0,30 Cu ≤0,25 Ca 0,0005-0,0150													
F22, Class 1	K21590	0,05-0,15	0,30-0,60	≤0,040	≤0,040	≤0,50	---	2,00-2,50	0,87-1,13	≥415	≥205	≥20	≥35	≤170	A, NT
F22, Class 3	K21590	0,05-0,15	0,30-0,60	≤0,040	≤0,040	≤0,50	---	2,00-2,50	0,87-1,13	≥515	≥310	≥20	≥30	156-207	A, NT
F22V	K31835	0,11-0,15	0,30-0,60	≤0,015	≤0,010	≤0,10	≤0,25	2,00-2,50	0,90-1,10	585-760	≥415	≥18	≥45	174-237	NT, QT
		Other elements Cb ≤ 0,07 Ti ≤ 0,030 Cu ≤0,20 V 0,25-0,35 B ≤0,002 Ca ≤0,015													
F23	K41650	0,04-0,10	0,10-0,60	≤0,030	≤0,010	≤0,50	---	1,90-2,60	0,05-0,30	≥510	≥400	≥20	≥40	≤220	NT
		Other elements Cb 0,02-0,08 V 0,20-0,30 B 0,0005-0,006 N≤0,03 AL≤0,030 W 1,45-1,75													
F24	K30736	0,05-0,10	0,30-0,70	≤0,020	≤0,010	0,15-0,45	---	2,20-2,60	0,90-1,10	≥585	≥415	≥20	≥40	≤248	NT
		Other elements T 0,06-0,10 V 0,20+-0,30 N ≤0,12 Al ≤0,020 B 0,0015-0,0070													
FR	K22035	≤0,20	0,40-1,06	≤0,045	≤0,050	0,25-0,50	1,60-2,24	---	---	≥435	≤315	≤25	≤38	≤197	A, N, NT
		Other elements Cu 0,75-1,25													
F36 CLASS 1	K21001	0,10-0,17	0,80-1,20	≤0,030	≤0,025	0,25-0,50	1,00-1,30	≤0,30	0,25-0,50	≥620	≤440	≤15	---	≤252	NT
		Other elements Cb 0,015-0,045 N ≤0,020 Al ≤0,050 Cu 0,50-0,80 V ≤0,02													
F36 CLASS 2	K21001	0,10-0,17	0,80-1,20	≤0,030	≤0,025	0,26-0,60	1,00-1,30	≤0,30	0,25-0,50	≥660	≤460	≤15	---	≤252	NT, QT
		Other elements Cb 0,015-0,045 N ≤0,020 Al ≤0,050 Cu 0,50-0,80 V ≤0,02													

Heat Treatments: A Annealing, N Normalizing, NT Normalizing and Tempering, QT Quenching and Tempering, SQ Solution Annealing and Quenching

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ASME/ASTM SA-182/SA-182M-07

Austenitic Stainless Steels (1)

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	Tensile Strength MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Hardness HB	Heat Treatment
F304	S30400	≤0,08	≤2,00	≤0,045	≤0,030	≤1,00	8,0-11,0	18,0-20,0	—	≥515	≥205	≥30	≥50	--	SQ
		Other elements N ≤0,10													
F304H	S30409	0,04-0,10	≤2,00	≤0,045	≤0,030	≤1,00	8,0-11,0	18,0-20,0	—	≥515	≥205	≥30	≥50		SQ
F304L	S30403	≤0,030	≤2,00	≤0,045	≤0,030	≤1,00	8,0-13,0	18,0-20,0	—	≤485	≥170	≥30	≥50	--	SQ
		Other elements N ≤0,10													
F304N	S30451	≤0,08	≤2,00	≤0,045	≤0,030	≤1,00	8,0-10,5	18,0-20,0	—	≥550	≥240	≥30	≥50	—	SQ
		Other elements N 0,10-0,16													
F304LN	S30453	≤0,030	≤2,00	≤0,045	≤0,030	≤1,00	8,0-10,5	18,0-20,0	—	≥515	≥205	≥30	≥50	—	SQ
		Other elements N 0,10-0,16													
F309H	S30909	0,04-0,10	≤2,00	≤0,045	≤0,030	≤1,00	12,0-15,0	22,0-24,0	—	≥515	≥205	≥30	≥50	—	SQ
F310	S31000	≤0,25	≤2,00	≤0,045	≤0,030	≤1,00	19,0-22,0	24,0-26,0	—	≥515	≥205	≥30	≥50	—	SQ
F310H	S31009	0,04-0,10	≤2,00	≤0,045	≤0,030	≤1,00	19,0-22,0	24,0-26,0	—	≥515	≥205	≥30	≥50	—	SQ
F310MoLN	S31050	≤0,030	≤2,00	≤0,030	≤0,015	≤0,40	21,0-23,0	24,0-26,0	2,00-3,00	≥540	≥255	≥30	≥40	—	SQ
		Other elements N 0,10-0,16													
F316	S31600	≤0,080	≤2,00	≤0,045	≤0,030	≤1,00	10,0-14,0	16,0-18,0	2,00-3,00	≥515	≥205	≥30	≥50	—	SQ
		Other elements N ≤0,10													
F316H	S31609	0,04-0,10	≤2,00	≤0,045	≤0,030	≤1,00	10,0-14,0	16,0-18,0	2,00-3,00	≥515	≥205	≥30	≥50		SQ
F316L	S31603	≤0,030	≤2,00	≤0,045	≤0,030	≤1,00	10,0-15,0	16,0-18,0	2,00-3,00	≥485	≥170	≥30	≥50	—	SQ
		Other elements N ≤0,10													
F316N	S31651	≤0,080	≤2,00	≤0,045	≤0,030	≤1,00	11,.0-14,0	16,0-18,0	2,00-3,00	≥550	≥240	≥30	≥50	—	SQ
		Other elements N 0,10-0,16													
F316LN	S31653	≤0,030	≤2,00	≤0,045	≤0,030	≤1,00	11,0-14,0	16,0-18,0	2,00-3,00	≥515	≥205	≥30	≥50	—	SQ
		Other elements N 0,10-0,16													
F316Ti	S31635	≤0,080	≤2,00	≤0,045	≤0,030	≤1,00	10,0-14,0	16,0-18,0	2,00-3,00	≥515	≥205	≥30	≥40	—	SQ
		Other elements N ≤0,10 5 x (C + N) ≤ Ti ≤ 0,70													
F317	S31700	≤0,080	≤2,00	≤0,045	≤0,030	≤1,00	11,0-15,0	11,0-15,0	3,0-4,0	≥515	≥205	≥30	≥50	—	SQ
F317L	S31703	≤0,030	≤2,00	≤0,045	≤0,030	≤1,00	11,0-15,0	18,0-20,0	3,0 4,0	≥485	≥170	≥30	≥50	—	SQ
F321	S32100	≤0,080	≤2,00	≤0,045	≤0,030	≤1,00	9,0-12,0	17,0-19,0		≥515	≥205	≥30	≥50	—	SQ
		Other elements 5 x C ≤ Ti ≤ 0,70													
F321H	S32109	0,04-0,10	≤2,00	≤0,045	≤0,030	≤1,00	9,0-12,0	17,0-19,0		≥515	≥215	≥30	≥50	—	SQ
		Other elements 4 x C ≤ Ti ≤ 0,70													
F347	S34700	≤0,080	≤2,00	≤0,045	≤0,030	≤1,00	9,0-13,0	17,0-20,0		≥515	≥205	≥30	≥50	—	SQ
		Other elements 10 x C ≤ Cb ≤ 1,10													
F347H	S34709	0,04-0,10	≤2,00	≤0,045	≤0,030	≤1,00	9,0-13,0	17,0-20,0		≥515	≥205	≥30	≥50	—	SQ
		Other elements 8 x C ≤ Cb ≤ 1,10													

Heat Treatment: SQ Solution Annealig and Quenching

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ASME/ASTM SA-182/SA-182M-07

Austenitic Stainless Steels (2)

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	Tensile Strength MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Hardness HB	Heat Treatment
F348	S34800	≤0,080	≤2,00	≤0,045	≤0,030	≤1,00	9,0-13,0	17,0-20,0		≥515	≥205	≥30	≥50	—	SQ
		Other elements Co ≤0,20 Ta ≤0,10 10 x C ≤ Cb ≤ 1,10													
F348H	S34809	0,04-0,10	≤2,00	≤0,045	≤0,030	≤1,00	9,0-13,0	17,0-20,0		≥515	≥205	≥30	≥50	—	SQ
		Other elements Co≤0,20 Ta≤0,10 8 x C ≤ Cb ≤ 1,10													
FXM-11	S21904	≤0,040	8,0-10,0	≤0,060	≤0,030	≤1,00	5,5-7,5	19,0-21,5		≥620	≥345	≥45	≥60	—	SQ
		Other elements N 0,15-0,40													
FXM-19	S20910	≤0,060	4,0-6,0	≤0,040	≤0,030	≤1,00	11,5-13,5	20,5-23,5	1,5-3,0	≥690	≥380	≥35	≥55	—	SQ
		Other elements Cb 0,10-0,30 N 0,20-0,40 V 0,10-0,30													
F20	N08020	≤0,070	≤2,00	≤0,045	≤0,035	≤1,00	32,0-38,0	19,0-21,0	2,0-3,0	≥550	≥240	≥30	≥50	—	SQ
		Other elements Cu 3,0-4,0 (8 x C) ≤ Cb ≥ 1,00													
F44	S31254	≤0,020	≤1,00	≤0,030	≤0,010	≤0,80	17,5-18,5	19,5-20,5	6,0-6,5	≥650	≥300	≥35	≥50	—	SQ
		Other elements Cu 0,50-1,00 N 0,18-0,22													
F45	S30815	0,05-0,10	≤0,80	≤0,040	≤0,030	1,40-2,00	10,0-12,0	20,0-22,0		≥600	≥310	≥40	≥50	—	SQ
		Other elements N 0,14-0,20 Ce 0,03-0,08													
F46	S30600	≤0,018	≤2,00	≤0,020	≤0,020	3,7-4,3	14,0-15,5	17,0-18,5	≤0,20	≥540	≥240	≥40	≥50	—	SQ
		Other elements Cu ≤0,50													
F47	S31725	≤0,030	≤2,00	≤0,045	≤0,030	≤0,75	13,0-17,5	18,0-20,0	4,0-5,0	≥525	≥205	≥40	≥50	—	SQ
		Other elements N ≤0,10													
F48	S31726	≤0,030	≤2,00	≤0,045	≤0,030	≤0,75	13,5-17,5	17,0-20,0	4,0-5,0	≥550	≥240	≥40	≥50	—	SQ
		Other elements N 0,10-0,20													
F49	S34565	≤0,030	5,0-7,0	≤0,030	≤0,010	≤1,00	16,0-18,0	23,0-25,0	4,0-5,0	≥795	≥415	≥35	≥40	—	SQ
		Other elements Cb ≤0,10 N 0,40-0,60													
F56	S33228	0,04-0,08	≤1,00	≤0,020	≤0,015	≤0,30	31,0-33,0	26,0-28,0		≥500	≥185	≥30	≥35	—	SQ
		Other elements Cb 0,6-1,0 Ce 0,05-0,10 Al ≤0,025													
F58	S31266	≤0,030	2,0-4,0	≤0,035	≤0,020	≤1,00	21,0-24,0	23,0-25,0	5,2-6,2	≥750	≥420	≥35	≥50	—	SQ
		Other elements N 0,35-0,60 Cu 1,00-2,50 W 1,50-2,50													
F62	N08367	≤0,030	≤2,00	≤0,040	≤0,030	≤1,00	23,5-25,5	20,0-22,0	6,0-7,0	≥655	≥310	≥30	≥50	—	SQ
		Other elements N 0,18-0,25 Cu ≤0,75													
F63	S32615	≤0,070	≤2,00	≤0,045	≤0,030	4,8-6,0	19,0-22,0	16,5-19,5	0,30-1,50	≥550	≥220	≥25	—	≤192	SQ
		Other elements Cu 1,50-2,50													
F64	S30601	≤0,015	0,50-0,80	≤0,030	≤0,013	5,0-5,8	17,0-18,0	17,0-18,0	≤0,20	≥620	≥275	≥35	≥50	≤217	SQ
		Other elements Cu ≤0,35 N ≤0,05													
F904L	N08904	≤0,020	≤2,00	≤0,040	≤0,030	≤1,00	23,0-28,0	19,0-23,0	4,0-5,0	≥490	≥215	≥35	—	—	SQ
		Other elements Cu 1,00-2,00 N ≤0,10													

Heat Treatment: SQ Solution Annealig and Quenching

ASME/ASTM SA-182/SA-182M-07

Ferritic-Austenitic Stainless Steels (Duplex)

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	ensile Strengt MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Hardness HB	Heat Treatment
F50	S31200	≤0,030	≤2,00	≤0,045	≤0,030	≤1,00	5,5-6,5	24,0-26,0	1,20-2,00	690-900	≥450	≥25	≥50	--	SQ
		Other elements N 0,14-0,20													
F51	S31803	≤0,030	≤2,00	≤0,030	≤0,020	≤1,00	4,5-6,5	21,0-23,0	2,5-3,5	≥620	≥450	≥25	≥45	—	SQ
		Other elements N 0,08-0,20													
F52	S32950	≤0,030	≤2,00	≤0,035	≤0,010	≤0,60	3,5-5,2	26,0-29,0	1,00-2,50	≥690	≥485	≥15	—	--	SQ
		Other elements N 0,15-0,35													
F53	S32750	≤0,030	≤1,20	≤0,035	≤0,020	≤0,80	6,0-8,0	24,0-26,0	3,0-5,0	≥800	≥550	≥15	—	≤310	SQ
		Other elements N 0,24-0,32 Cu ≤0,50													
F54	S39274	≤0,030	≤1,00	≤0,030	≤0,020	≤0,80	6,0-8,0	24,0-26,0	2,5-3,5	≥800	≥550	≥15	≥30	≤310	SQ
		Other elements N 0,24-0,32 Cu 0,20-0,80 W 1,50-2,50													
F55	S32760	≤0,030	≤1,00	≤0,030	≤0,010	≤1,00	6,0-8,0	24,0-26,0	3,0-4,0	750-895	≥550	≥25	≥45	—	SQ
		Other elements N 0,20-0,30 Cu 0,50-1,00 W 0,50-1,00													
F57	S39277	≤0,025	≤0,80	≤0,025	≤0,002	≤0,80	6,5-8,0	24,0-26,0	3,0-4,0	≥820	≥585	≥25	≥50	—	SQ
		Other elements Cu 1,20-2,00 W 0,80-1,20 N 0,23-0,33													
F59	S32520	≤0,030	≤1,5	≤0,035	≤0,020	≤0,80	5,5-8,0	24,0-26,0	3,0-5,0	≥770	≥550	≥25	≥40	—	SQ
		Other elements N 0,20-0,35 Cu 0,50-3,00													
F60	S32205	≤0,030	≤2,00	≤0,030	≤0,020	≤1,00	4,5-8,5	22,0-23,0	3,0-3,5	≥655	≥485	≥25	≥45	—	SQ
		Other elements N 0,14-0,20													
F61	S32550	≤0,040	≤1,50	≤0,040	≤0,030	≤1,00	4,5-6,5	24,0-27,0	2,9-3,9	≥750	≥550	≥25	≥50	—	SQ
		Other elements Cu 1,50-2,50 N 0,10-0,25													
F65	S32906	≤0,030	0,80-1,50	≤0,030	≤0,030	≤0,80	5,8-7,5	28,0-30,0	1,5-2,6	≥750	≥550	≥25	—	—	SQ
		Other elements Cu≤0,80 N 0,30-0,40													

Heat Treatment: SQ Solution Annealig and Quenching

ASME/ASTM SA-350/SA-350M-03

Carbon and Low Alloy Steel Forgings For Low Temperature Service.

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	Tensile Strength MPa	Yield Strength (0,2%) MPa	Elongation %	Reduction of Area %	Hardness HB	Heat Treatment
LF1	K03009	≤0,30	0,60-1,35	≤0,035	≤0,040	0,15-0,30	≤0,40	≤0,30	≤0,12	415-585	≥205	≥25	≥38	≤197	N, NT, QT
		Other elements Cu ≤0,40 Cb ≤ 0,02 V ≤0,08 (Cu+Ni+Cr+V+Mo) ≤1,00 (Cr+Mo) ≤0,32													
LF2 Class 1	K03011	≤0,30	0,60-1,35	≤0,035	≤0,040	0,15-0,30	≤0,40	≤0,30	≤0,12	485-655	≥250	≥22	≥30	≤197	N, NT, QT
LF2 Class 2		Other elements Cu ≤0,40 Cb ≤ 0,02 V ≤0,08 (Cu+Ni+Cr+V+Mo) ≤1,00 (Cr+Mo) ≤0,32								485-655	≥250	≥22	≥30	≤197	N, NT, QT
LF3 Class 1	K32025	≤0,20	≤0,90	≤0,035	≤0,040	0,20-0,35	3,3-3,7	≤0,30	≤0,12	485-655	≥250	≥22	≥35	≤197	N, NT, QT
LF 3 Class 2		Other elements Cb ≤ 0,02 V ≤0,03 (Cr+Mo) ≤0,32								485-655	≥250	≥22	≥35	≤197	N, NT, QT
LF5 Class 1	K13050	≤0,30	0,60-1,35	≤0,035	≤0,040	0,20-0,35	1,0-2,0	≤0,30	≤0,12	415-585	≥205	≥25	≥38	≤197	N, NT, QT
LF5 Class 2		Other elements Cb ≤ 0,02 V ≤0,03								485-655	≥250	≥22	≥35	≤197	N, NT, QT
LF6 Class 1	K12202	≤0,22	1,15-1,50	≤0,025	≤0,025	0,15-0,30	≤0,40	≤0,30	≤0,12	455-630	≥360	≥22	≥40	≤197	N, NT, QT
LF6 Class 2, 3		Other elements Cb ≤ 0,02 V 0,04-0, 11 N 0,01-0,030								515-690	≥415	≥20	≥40	≤197	N, NT, QT
LF9	K22036	≤0,20	0,40-1,06	≤0,035	≤0,040		1,60-2,24	≤0,30	≤0,12	435-605	≥315	≥25	≥38	≤197	N, NT, QT
		Other elements Cb ≤ 0,02 V ≤0,03													
LF787 Class 2	K20747	≤0,07	0,40-0,70	≤0,025	≤0,025	≤0,40	0,70-1,00	0,60-0,90	0,15-0,25	450-585	≥380	≥20	≥45	≤197	NP, QP
LF787 Class 3		Other elements Cb ≤ 0,02 V ≤0,03								515-655	≥450	≥20	≥45	≤197	NP, QP

Heat Treatments: N Normalizing, NT Normalizing and Tempering, QT Quenching and Tempering, NP Normalized and Precipitation Heat Treated, QP Quenched and Precipitation Heat Treated

Charpy V-Notch Energy Requirements for Standard Size (10 x 10 mm) Specimens

Grade	Test Temperature ºC	Minimum Impact Energy Required for Average of Each Set of Three Specimens Joules	Minimum Impact Energy for One Specimen only of a Set Joules
LF1	-29	18	14
LF2 Class 1	-46	20	16
LF2 Class 2	-18	27	20
LF3 Class 1	-101	20	16
LF 3 Class 2	-101	27	20
LFS Class 1	-59	20	16
LFS Class 2	-59	20	16
LF6 Class 1	-51	20	16
LF6 Class 2	-51	27	20
LF6 Class 3	-18	27	20
LF9	-73	18	14
LF787 Class 2	-59	27	20
LF787 Class 3	-73	27	20

STEEL FORGINGS FOR THE PRESSURE VESSEL INDUSTRY

ASME/ASTM A 266/A 266M-03

Carbon Steel Forgings for Pressure Vessel Components

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	Cb	Ti	Tensile Strength MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Heat Treatment
1	K03506	≤0,30	0,40-1,05	≤0,025	≤0,025	0,15-0,35	—	—	—	—	—	415-585	≥205	23	38	A, N, NT, QT
2	K03506	≤0,30	0,40-1,05	≤0,025	≤0,025	0,15-0,35	—	—	—	—	—	485-655	≥250	20	33	A, N, NT, QT
3	K05001	≤0,35	0,80-1,35	≤0,025	≤0,025	0,15-0,35	—	—	—	—	—	515-690	≥260	19	30	A, N, NT, QT
4	K03017	≤0,30	0,80-1,35	≤0,025	≤0,025	0,15-0,35	—	—	—	—	—	485-655	≥250	20	33	A, N, NT, QT

ASME/ASTM A 336/A 336M-07

Alloy Steel Forgings for Pressure and High Temperature Parts

Grade	UNS	C	Mn	P	S	Si	Ni	Cr	Mo	Cb	Ti	Tensile Strength MPa	Yield Strength (0,2%) Mpa	Elongation %	Reduction of Area %	Heat Treatment
F1	K12520	0,20-0,30	0,60-0,80	≤0,025	≤0,025	0,20-0,35	—	—	0,40-0,60	—	—	485-660	≥275	20	40	A, NT, QT
F11, Class 2	K11572	0,10-0,20	0,30-0,80	≤0,025	≤0,025	0,50-1,00	—	1,00-1,50	0,45-0,65	—	—	485-660	≥275	20	40	A, NT, QT
F11, Class 3	K11572	0,10-0,20	0,30-0,80	≤0,025	≤0,025	0,50-1,00	—	1,00-1,50	0,45-0,65	—	—	515-690	≥310	18	40	A, NT, QT
F11, Class 1	K11597	0,05-0,15	0,30-0,60	≤0,025	≤0,025	0,50-1,00	—	1,00-1,50	0,45-0,65	—	—	415-585	≥205	20	45	A, NT, QT
F12	K11564	0,10-0,20	0,30-0,80	≤0,025	≤0,025	0,10-0,60	—	0,80-1,10	0,45-0,65	—	—	485-660	≥275	20	40	A, NT, QT
F5	K41545	≤0,15	0,30-0,60	≤0,025	≤0,025	≤0,50	≤0,50	4,0-6,0	0,45-0,65	—	—	415-585	≥250	20	40	A, NT, QT
F5A	K42544	≤0,25	≤0,60	≤0,025	≤0,025	≤0,50	≤0,50	4,0-6,0	0,45-0,65	—	—	550-725	≥345	19	35	A, NT, QT
F9	K90941	≤0,15	0,30-0,60	≤0,025	≤0,025	0,50-1,00	—	8,0-10,0	0,90-1,10	—	—	585-760	≥380	20	40	A, NT, QT
F6	S41000	≤0,12	≤1,00	≤0,025	≤0,025	≤1,00	≤0,50	11,5-13,5	—	—	—	585-760	≥380	18	35	A, NT, QT
F21, Class 1	K31545	0,05-0,15	0,30-0,60	≤0,025	≤0,025	≤0,50	—	2,7-3,3	0,80-1,06	—	—	415-585	≥205	20	45	A, NT, QT
F21, Class 3	K31545	0,05-0,15	0,30-0,60	≤0,025	≤0,025	≤0,50	—	2,7-3,3	0,80-1,06	—	—	515-690	≥310	19	40	A, NT, QT
F22, Class 1	K21590	0,05-0,15	0,30-0,60	≤0,025	≤0,025	≤0,50	—	2,00-2,50	0,90-1,10	—	—	415-585	≥205	20	45	A, NT, QT
F22, Class 3	K21590	0,05-0,15	0,30-0,60	≤0,025	≤0,025	≤0,50	—	2,00-2,50	0,90-1,10	—	—	515-690	≥310	19	40	A, NT, QT
F91	K90901	0,08-0,12	0,30-0,60	≤0,025	≤0,025	0,20-0,50	≤0,40	8,0-9,5	0,85-1,05	0,06-0,10	≤0,01	585-760	≥415	20	40	A, NT, QT
		Other elements V 0,18-0,25 N 0,03-0,07 Al ≤0,02 Zr ≤0,01														
F911	K91061	0,09-0,13	0,30-0,60	≤0,020	≤0,010	0,10-0,50	≤0,40	8,5-9,5	0,90-1,10	0,06-0,10	≤0,01	620-830	≥440	20	40	A, NT, QT
		Other elements V 0,18-0,25 N 0,04-0,09 Al ≤0,02 B 0,0003-0,006 W 0,90-1,10 Zr ≤0,01														
F3V	K31830	0,10-0,15	0,30-0,60	≤0,020	≤0,020	≤0,10	—	2,7-3,3	0,90-1,10	—	0,015-0,035	585-760	≥415	18	45	A, NT, QT
		Other elements V 0,20-0,30 B 0,001-0,003														
F3VCb	K31390	0,10-015	0,30-0,60	≤0,020	≤0,010	≤0,10	≤0,25	2,7-3,3	0,90-1,10	0,015-0,070	≤0,015	585-760	≥415	18	45	A, NT, QT
		Other elements V 0,20-0,30 Cu ≤0,25 Ca 0,0005-0,0150														
F22V	K31835	0,11-0,15	0,30-0,60	≤0,015	≤0,010	≤0,10	≤0,25	2,00-2,50	0,90-1,10	≤0,07	≤0,030	585-760	≥415	18	45	NT, QT
		Other elements V 0,25-0,35 B ≤0,0020 Cu ≤0,20 Ca ≤0,015														

Heat Treatments: A Annealing, N Normalizing, NT Normalizing and Tempering, QT Quenching and Tempering

ALEACIONES DE ALTO CONTENIDO EN NIQUEL
HIGH NICKEL ALLOYS
ALLIAGES À HAUT CONTENU DE NICKEL
HOCHNICKEL LEGIERUNGEN

Alloy	UNS	DIN	Werkstoff	Ni	Cr	Fe	Si	Mo	Co	Nb	C	P	S	Al	Ti	N	Cu	Mn	Other elements
Aleaciones resistentes a la corrosión / Corrosion resistant alloys / Alliages resistants à la corrosion / Korrosionbeständige																			
200	N 02200	Ni99,2	2.4066	≥99,2	—	≤ 0,40	≤ 0,25	—	—	—	≤ 0,10	—	≤0,005	—	≤ 0.10	—	≤ 0,25	≤ 0,35	Mg ≤ 0,15
201	N 02201	LC-Ni 99	2.4068	≥ 99,0	—	≤ 0,40	≤ 0,25	—	—	—	≤ 0,02	—	≤0,005	—	≤ 0,10	—	≤ 0,25	≤ 0,35	Mg ≤ 0,15
400	N 04400	NiCu30Fe	2.4360	≥ 63,0	—	1,0 - 2,5	≤ 0,50	—	—	—	≤ 0,15	—	≤0,020	≤ 0,5	≤ 0,30	—	28,0 - 34,0	≤ 2,00	Al ≤ 0,50
K-500	N 05500	NiCu30Al	2.4375	≥ 63,0	—	0,50 - 2,0	≤ 0,50	—	—	—	≤ 0,20	—	≤0,015	2,20 - 3,50	0,30 - 1,00	—	27,0 - 34,0	≤ 1,50	
B-2	N 10665	NiMo28	2.4617	Balance	≤ 1,00	≤ 2,00	≤ 0,08	26,0 - 30,0	≤ 1,0	—	≤ 0,010	≤0,025	≤0,015	—	—	—	≤ 0.50	≤ 1,00	
B-4	N 10629	NiMo29Cr	2.4600	≥ 65,0	0,50 - 3,0	1,0 - 6,0	≤ 0.10	26,0 - 32,0	≤ 3,0	≤ 0,40	≤ 0,010	≤0,025	≤0,015	0,10 - 0,50	≤ 0,20	—	≤ 0,50	≤ 3,00	W ≤3,0 V ≤0,20
C-4	N 06455	NiMo16Cr16Ti	2.4610	Balance	14,0 - 18,0	≤ 3,0	≤ 0,08	14,0 - 17,0	≤ 2,0	—	≤ 0,015	≤0,025	≤0,015	—	≤ 0,70	—	≤ 0,50	≤ 1,00	
617	N 06617	NiCr23Co12Mo	2.4663	Balance	20,0 - 23,0	≤ 2,0	≤ 0,20	8,50 - 10,0	11,0 - 14,0	—	0,05 - 0,10	≤0,010	≤0,010	0,70 - 1,40	0,20 - 0,60	—	≤ 0,50	≤ 0,20	B ≤ 0.006
625	N 06625	NiCr22Mo9Nb	2.4856	≥ 58,0	20,0 - 23,0	≤ 5,0	≤ 0.50	8,0 - 10,0	≤ 1,00	3,15 - 4,15	≤ 0,10	≤0,020	≤0,015	≤ 0.40	≤ 0,40	—	≤ 0,50	≤ 0,50	
59	N 06059	NiCr23Mo16Al	2.4605	Balance	22,0 - 24,0	≤ 1,5	≤ 0,10	15,0 - 16,5	≤ 0,30	—	≤ 0,010	≤0.025	≤0,015	0,10 - 0,40	—	—	≤ 0,50	≤ 0,50	
C-276	N 10276	NiMo16Cr15W	2.4819	Balance	14,5 - 16,5	4,0 - 7,0	≤ 0,08	15,0 - 17,0	≤ 2,50	—	≤ 0,010	≤0,020	≤0,015	—	—	—	≤ 0.50	≤ 1,00	W ≤3,00 V ≤0,35
C-22	N 06022	NiCr21Mo14W	2.4602	Balance	20,0 - 22,5	2,0 - 6,0	≤ 0.08	12,5 - 14,5	≤ 2,50	—	≤ 0,010	≤0,025	≤0,015	—	—	—	≤ 2,50	≤ 0,50	W ≤2,50 V ≤0,35
718	N 07718	NiCr19NbMo	2.4668	50,0 - 55,0	17,0 - 21,0	Balance	≤0,35	2,80 - 3,30	≤ 1,00	4,70 - 5,50	0,02 - 0,08	≤0,015	≤0,015	0,30 - 0,70	0,60 - 1,20	—	≤ 0,30	≤ 0,35	B 0,002 - 0,006
600 L	N 06600	LC-NiCr15Fe	2.4817	≥ 72,0	14,0 - 17,0	6,0 - 10,0	≤ 0,50	—	≤ 1,00	—	≤ 0,025	≤0,020	≤0,015	≤ 0,30	≤ 0,30	—	≤ 0.50	≤ 1,00	B ≤ 0,006
825	N 08825	NiCr21Mo	2.4858	38,0 - 46,0	19,5 - 23,5	Balance	≤ 0,50	2,50 - 3,50	≤ 1,00	—	≤ 0,025	≤0,020	≤0,015	≤ 0,20	0,60 - 1,20	—	1,50 - 3,00	≤ 1,00	
20	N 08020	NiCr20CuMo	2.4660	32,0 - 38,0	19,0 - 21,0	Balance	≤ 1,00	2,00 - 3,00	≤ 1,50	≥8xC≥1,00	≤ 0,07	≤0,025	≤0,015	—	—	—	3,00 - 4,00	≤ 2,00	
31	N 08031	X1NiCrMoCu 32 28 7	1.4562	30,0 - 32,0	26,0 - 28,0	Balance	≤ 0,30	6,00 - 7,00	—	—	≤ 0,015	≤0,020	≤0,010	—	—	0,15 - 0,25	1,00 - 1,40	≤ 2,00	
28	N 08028	X1NiCrMoCuN 31 27 4	1.4563	30,0 - 32,0	26,0 - 28,0	Balance	≤ 0,70	3,00 - 4,00	—	—	≤ 0,020	≤0,030	≤0,010	—	—	≤ 0,11	0,70 - 1,50	≤ 2,00	
926	N 08926	NiCrMoCuN 25 20 6	1.4529	24,0 - 26,0	19,0 - 21,0	Balance	≤ 0,50	6,00 - 7,00	—	—	≤ 0,020	≤0,030	≤0,010	—	—	0,15 - 0,25	0,50 - 1,50	≤ 1,00	
CuNi70/30	C 71500	CuNi30Mn1Fe	2.0882	30,0 - 32,0	—	0,4 - 1,0	—	—	—	—	—	—	—	—	—	—	Balance	0,50 - 1,00	
CuNi90/10	C70600	CuNi10Fe1Mn	2.0872	9,0 - 11,0	—	1,0 - 1,8	—	—	—	—	—	—	—	—	—	—	Balance	0,20 - 1,00	Zn ≤ 0,5
Aleaciones resistentes al calor / Heat resistant alloys / Hochwarmfeste legierungen / Alliages pour utilisation à températures élevées																			
75	N 06075	NiCr20Ti	2.4951	Balance	18,0 - 21,0	≤ 5,00	≤1,00	≤ 1,0	≤ 5,00	—	0,08 - 0,15	≤0,020	≤0,015	≤ 0,30	0,20 - 0,60	—	≤ 0,50	≤ 1,00	B ≤ 0,006
600	N 06600	NiCr15Fe	2.4816	≥ 72,0	14,0 - 17,0	6,00 - 10,00	≤ 0,50	—	≤ 1,00	—	0,05 - 0,10	≤0,020	≤0,015	≤ 0,30	≤ 0,30	—	≤ 0,50	≤ 1,00	B ≤ 0,006
601	N 06601	NiCr23Fe	2.4851	58,0 - 63,0	21,0 - 25,0	≤ 18,00	≤ 0,50	—	≤ 1,00	—	0,03 - 0,10	≤0,020	≤0,015	1,00 - 1,70	≤ 0,50	—	≤ 0,50	≤ 1,00	B ≤ 0,006
DS		X8NiCrSi 38-18	1.4862	35,0 - 39,0	17,0 - 19,0	Balance	1,50 - 2,50	—	—	—	≤ 0,10	≤0,030	≤0,030	—	≤ 0,20	—	≤ 0,50	0,80 - 1,50	
330	N 08330	X12NiCrSi 36-16	1.4864	33,0 -37,0	15,0 - 17,0	Balance	1,00 - 2,00	—	—	—	≤ 0,15	≤0.045	≤0,015	—	—	≤ 0,11	—	≤ 2,00	
80A	N 07080	NiCr20TiAl	2.4952	≥ 65,0	18,0 - 21,0	≤ 1,50	≤ 1,00	—	≤ 1,00	—	0,04 - 0,10	≤0.020	≤0,015	1,00 - 1,80	1,80 - 2,70	—	≤ 0.20	≤ 1,00	
602CA	N 06025	NiCr25FeAlY	2.4633	Balance	24,0 - 26,0	8,00 - 11,00	≤ 0,50	—	—	—	0,15 - 0,25	≤0,020	≤0,010	1,80 - 2,40	0,10 - 0,20	—	≤ 0,10	≤ 0,50	Y 0,05 - 0,12 Zr 0,01 - 0,10
617	N 06617	NiCr23Co12Mo	2.4663	Balance	20,0 - 23,0	≤ 2,00	≤ 0,20	8,50 - 10,0	11,0 - 14,0	—	0,05 - 0,10	≤0,010	≤0,010	0,70 - 1,40	0,20 - 0,60	—	≤ 0,50	≤ 0,20	B ≤ 0,006
718	N 07718	NiCr19Fe19Nb5Mo3	2.4668	50,0 - 55,0	17,0 - 21,0	Balance	≤ 0,35	2,80 - 3,30	≤ 1,00	4,70 - 5,50	0,02 - 0,08	≤0.015	≤0,015	0,30 - 0,70	0,60 - 1,20	—	≤ 0,30	≤ 0,35	B ≤ 0,006
800HT	N 08811	X8NiCrAlTi 32-21	1.4959	30,0 - 34,0	19,0 - 22,0	Balance	≤ 0,70	—	≤ 0,50	—	0,05 - 0,10	≤0,015	≤0,010	0,20 - 0,65	0,25 - 0,65	≤ 0,030	≤ 0,50	≤ 1,50	
800H	N 08810	X5NiCrAlTi 31-20	1.4958	30,0 - 32,5	19,0 - 22,0	Balance	≤ 0,70	—	≤ 0,50	≤ 0,10	0,03 - 0,08	≤0,015	≤0,010	0,20 - 0,50	0,20 - 0,50	≤ 0,030	≤ 0,50	≤ 1,50	
NiCr80/20	N 06003	NiCr80-20	2.4869	≥ 75,0	19,0 - 21,0	≤ 1,00	0,50 - 2,00	—	≤ 1,00	—	≤ 0.15	≤0,020	≤0,015	≤ 0,30	—	—	≤ 0,50	≤ 1,00	
NiCr70/30	N 06008	NiCr70-30	2.4658	≥ 60,0	29,0 - 32,0	≤ 5,00	0,50 - 2,00	—	≤ 1,00	—	≤ 0,10	≤0,020	≤0,015	≤ 0,30	—	—	≤ 0,50	≤ 1,00	
36	K 93600	Ni36	1.3912	35,0 - 37,0		Balance	≤ 0,50	—	—	—	≤ 0,10	—	—	—	—	—	—	≤ 0,50	

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