TABLE 2 *Continued*

Identification Symbol	UNS Designation	Grade	Composition, %										
			Carbon	Manganese	Phosphorus	Sulfur	Silicon	Nickel	Chromium	Molybdenum	Columbium	Titanium	Other Elements
F 23	K41650	2.25 % chromium, 1.6 % tungsten, 0.25 % vanadium, plus molybdenum, columbium, and boron	0.04–0.10	0.10–0.60	0.030	0.010	0.50		1.90-2.60	0.05-0.30	0.02–0.08		V 0.20–0.30 B 0.0005–0.006 N 0.030 Al 0.030 W 1.45–1.75
F 24		2.25 % chromium, 1 % molybdenum, 0.25 % vanadium plus titanium and boron	0.05–0.10	0.30–0.70	0.020	0.010	0.15–0.45		2.20–2.60	0.90–1.10		0.06-0.10	V 0.20–0.30 N 0.12 Al 0.020 B 0.0015–0.0070
FR	K22035	2 % nickel, 1 % copper	0.20	0.40–1.06	0.045	0.050		1.60–2.24					Cu 0.75–1.25
						Martensitic Stainless Steels							
F 122	K92930	11 % chromium, 2 % tungsten, 0.2 % vanadium, plus molybdenum, columbium, copper, nickel, nitrogen, and boron	0.07–0.14	0.70	0.020	0.010	0.50	0.50	10.00–12.50	0.25–0.60	0.04–0.10		V 0.15–0.30 B 0.005 N 0.040–0.100 Al 0.040 Cu 0.30–1.70 W 1.50–2.50
F 6a	S41000	13 % chromium	0.15	1.00	0.040	0.030	1.00	0.50	11.5–13.5				
F 6b	S41026	13 % chromium, 0.5 % molybdenum	0.15	1.00	0.020	0.020	1.00	1.00–2.00	11.5–13.5	0.40–0.60			Cu 0.50
F 6NM	S41500	13 % chromium, 4 % nickel	0.05	0.50–1.00	0.030	0.030	0.60	3.5–5.5	11.5–14.0	0.50–1.00			
						Ferritic Stainless Steels							
F XM-27Cb[E]	S44627	27 chromium, 1 molybdenum	0.010	0.40	0.020	0.020	0.40	0.50	25.0–27.5	0.75–1.50	0.05–0.20		N 0.015 Cu 0.20
F 429	S42900	15 chromium	0.12	1.00	0.040	0.030	0.75	0.50	14.0–16.0				
F 430	S43000	17 chromium	0.12	1.00	0.040	0.030	0.75	0.50	16.0–18.0				
						Austenitic Stainless Steels							
F 304[F]	S30400	18 chromium, 8 nickel	0.08	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0				
F 304H	S30409	18 chromium, 8 nickel	0.04–0.10	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0				
F 304L[F]	S30403	18 chromium, 8 nickel, low carbon	0.030	2.00	0.045	0.030	1.00	8.0–13.0	18.0–20.0				
F 304N[G]	S30451	18 chromium, 8 nickel, modified with nitrogen	0.08	2.00	0.045	0.030	1.00	8.0–10.5	18.0–20.0				
F 304LN[G]	S30453	18 chromium, 8 nickel, modified with nitrogen	0.030	2.00	0.045	0.030	1.00	8.0–10.5	18.0–20.0				
F 309H	S30909	23 chromium, 13.5 nickel	0.04–0.10	2.00	0.045	0.030	1.00	12.0–15.0	22.0–24.0				
F 310	S31000	25 chromium, 20 nickel	0.25	2.00	0.045	0.030	1.00	19.0–22.0	24.0–26.0				
F 310H	S31009	25 chromium, 20 nickel	0.04–0.10	2.00	0.045	0.030	1.00	19.0–22.0	24.0–26.0				
F 310MoLN	S31050	25 chromium, 22 nickel, modified with molybdenum and nitrogen, low carbon	0.030	2.00	0.030	0.015	0.40	21.0–23.0	24.0–26.0	2.00–3.00			N 0.10–0.16
F 316[F]	S31600	18 chromium, 8 nickel, modified with molybdenum	0.08	2.00	0.045	0.030	1.00	10.0–14.0	16.0–18.0	2.00–3.00			

TABLE 2 *Continued*

Identification Symbol	UNS Designation	Grade	Composition, %										
			Carbon	Manganese	Phosphorus	Sulfur	Silicon	Nickel	Chromium	Molybdenum	Columbium	Titanium	Other Elements
F 316H	S31609	18 chromium, 8 nickel, modified with molybdenum	0.04–0.10	2.00	0.045	0.030	1.00	10.0–14.0	16.0–18.0	2.00–3.00			
F 316L[F]	S31603	18 chromium, 8 nickel, modified with molybdenum, low carbon	0.030	2.00	0.045	0.030	1.00	10.0–15.0	16.0–18.0	2.00–3.00			
F 316N[G]	S31651	18 chromium, 8 nickel, modified with molybdenum and nitrogen	0.08	2.00	0.045	0.030	1.00	11.0–14.0	16.0–18.0	2.00–3.00			
F 316LN[G]	S31653	18 chromium, 8 nickel, modified with molybdenum and nitrogen	0.030	2.00	0.045	0.030	1.00	11.0–14.0	16.0–18.0	2.00–3.00			
F 317	S31700	19 chromium, 13 nickel, 3.5 molybdenum	0.08	2.00	0.045	0.030	1.00	11.0–15.0	18.0–20.0	3.0–4.0			
F 317L	S31703	19 chromium, 13 nickel, 3.5 molybdenum	0.030	2.00	0.045	0.030	1.00	11.0–15.0	18.0–20.0	3.0–4.0			
F 321	S32100	18 chromium, 8 nickel modified with titanium	0.08	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0			[H]	
F 321H	S32109	18 chromium, 8 nickel, modified with titanium	0.04–0.10	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0			[I]	
F 347	S34700	18 chromium, 8 nickel modified with columbium	0.08	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0		[J]		
F 347H	S34709	18 chromium, 8 nickel, modified with columbium	0.04–0.10	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0		[K]		
F 348	S34800	18 chromium, 8 nickel modified with columbium	0.08	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0		[J]		Co 0.20 Ta 0.10
F 348H	S34809	18 chromium, 8 nickel, modified with columbium	0.04–0.10	2.00	0.045	0.030	1.00	9.0–13.0	17.0–20.0		[K]		Co 0.20 Ta 0.10
F XM-11	S21904	20 chromium, 6 nickel, 9 manganese	0.040	8.0–10.0	0.060	0.030	1.00	5.5–7.5	19.0–21.5				N 0.15–0.40
F XM-19	S20910	22 chromium, 13 nickel, 5 manganese	0.06	4.0–6.0	0.040	0.030	1.00	11.5–13.5	20.5–23.5	1.50–3.00	0.10–0.30		N 0.20–0.40 V 0.10–0.30
F 10	S33100	20 nickel, 8 chromium	0.10–0.20	0.50–0.80	0.040	0.030	1.00–1.40	19.0–22.0	7.0–9.0				
F 20	N08020	35 nickel, 20 chromium, 3.5 copper, 2.5 molybdenum	.07	2.00	0.045	0.035	1.00	32.0–38.0	19.0–21.0	2.00–3.00	8xCmin –1.00		Cu 3.0–4.0
F 44	S31254	20 chromium, 18 nickel, 6 molybdenum, low carbon	0.020	1.00	0.030	0.010	0.80	17.5–18.5	19.5–20.5	6.0–6.5			Cu 0.50–1.00 N 0.18–0.22
F 45	S30815	21 chromium, 11 nickel modified with nitrogen and cerium	0.05–0.10	0.80	0.040	0.030	1.40–2.00	10.0–12.0	20.0–22.0				N 0.14–0.20 Ce 0.03–0.08
F 46	S30600	18 chromium, 15 nickel, 4 silicon	0.018	2.00	0.020	0.020	3.7–4.3	14.0–15.5	17.0–18.5	0.20			Cu 0.50
F 47	S31725	19 chromium, 15 nickel, 4 molybdenum	0.030	2.00	0.045	0.030	0.75	13.0–17.5	18.0–20.0	4.0–5.0			N 0.10
F 48	S31726	19 chromium, 15 nickel, 4 molybdenum	0.030	2.00	0.045	0.030	0.75	13.5–17.5	17.0–20.0	4.0–5.0			N 0.10–0.20

TABLE 2 Chemical Requirements

NOTE 1—Tungsten is a new element for Table 2.

Element, % (max, except where range is given)	CF3, CF3A	CF8, CF8A	CF3M, CF-3MA	CF8M	CF3MN	CF8C	CF10	CF-10M (J92-901)	CH8	CH10	CH20	CK20	HK30	HK40	HT30	CF-10MC	CN7M	CN-3MN	CD-4MCu	CE8MN	CG-6MMN	CG8M	CF10S-MnN	CT15C	CK-3MCuN	CE20N	CG-3M (J92-999)	CD3M-WCuN[A]
Carbon	0.03	0.08	0.03	0.08	0.03	0.08	0.04–0.10	0.04–0.10	0.08	0.04–0.10	0.04–0.20	0.04–0.20	0.25–0.35	0.35–0.45	0.25–0.35	0.10	0.07	0.03 max	0.04	0.08	0.06	0.08	0.10	0.05–0.15	0.025	0.20	0.03	0.03
Manganese	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	2.00	1.50	1.50	2.00 max	1.00	1.00	4.00–6.00	1.50	7.00–9.00	0.15–1.50	1.20	1.50	1.50	1.00
Silicon	2.00	2.00	1.50	1.50	1.50	2.00	2.00	1.50	1.50	2.00	2.00	1.75	1.75	1.75	2.50	1.50	1.50	1.00 max	1.00	1.50	1.00	1.50	3.50–4.50	0.50–1.50	1.00	1.50	1.50	1.00
Sulfur	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.010 max	0.04	0.040	0.030	0.04	0.030	0.03	0.010	0.040	0.04	0.025
Phosphorus	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040 max	0.04	0.040	0.040	0.04	0.060	0.03	0.045	0.040	0.04	0.030
Chromium	17.0–21.0	18.0–21.0	17.0–21.0	18.0–21.0	17.0–21.0	18.0–21.0	18.0–21.0	18.0–21.0	22.0–26.0	22.0–26.0	22.0–26.0	23.0–27.0	23.0–27.0	23.0–27.0	13.0–17.0	15.0–18.0	19.0–22.0	20.0–22.0	24.5–26.5	22.5–25.5	20.50–23.50	18.0–21.0	16.0–18.0	19.0–21.0	19.5–20.5	23.0–26.0	18.0–21.0	24.0–26.0
Nickel	8.0–12.0	8.0–11.0	9.0–13.0	9.0–12.0	9.0–13.0	9.0–12.0	8.0–11.0	9.0–12.0	12.0–15.0	12.0–15.0	12.0–15.0	19.0–22.0	19.0–22.0	19.0–22.0	33.0–37.0	13.0–16.0	27.5–30.5	23.5–25.5	4.75–6.00	8.0–11.0	11.50–13.50	9.0–13.0	8.0–9.0	31.0–34.0	17.5–19.5	8.0–11.0	9.0–13.0	6.5–8.5
Molybdenum	0.50	0.50	2.0–3.0	2.0–3.0	2.0–3.0	0.50	0.50	2.0–3.0	0.50	0.50	0.50	0.50	0.50	0.50	0.50	1.75–2.25	2.0–3.0	6.0–7.0	1.75–2.25	3.0–4.5	1.50–3.00	3.0–4.0	. . .	. . .	6.0–7.0	0.50	3.0–4.0	3.0–4.0
Columbium (niobium)	. . .	. . .	. . .	. . .	. . .	[B]	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	[C]	. . .	. . .	. . .	. . .	0.10–0.30	. . .	. . .	0.50–1.50	. . .	. . .	. . .	. . .
Vanadium	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.10–0.30	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Nitrogen	. . .	. . .	. . .	. . .	0.10–0.20	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.18–0.26	. . .	0.10–0.30	0.20–0.40	. . .	0.08–0.18	. . .	0.18–0.24	0.08–0.20	. . .	0.20–0.30
Copper	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	3.0–4.0	0.75 max	2.75–3.25	. . .	. . .	. . .	. . .	. . .	0.50–1.00	. . .	. . .	0.5–1.0
Tungsten	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.5–1.0
Iron	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	Bal	. . .	. . .

[A] % Cr + 3.3 % Mo + 16 % N ≥ 40.
[B] Grade CF8C shall have a columbium content of not less than 8 times the carbon content but not over 1.00 %.
[C] Grade CF10MC shall have a columbium content of not less than 10 times the carbon content but not over 1.20 %.

TABLE 1 Chemical Requirements

Grade	UNS Designation[A]	Composition, %[B]																
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Titanium	Columbium	Tantalum, max	Nitrogen[C]	Vanadium	Copper	Cerium	Boron	Aluminum
. . .	S20400	0.030	7.0-9.0	0.045	0.030	1.00	15.0-17.0	1.50-3.00	. . .	. . .	. . .	. . .	0.15-0.30	. . .	. . .	. . .	. . .	. . .
TPXM-19	S20910	0.06	4.0-6.0	0.045	0.030	1.00	20.5–23.5	11.5–13.5	1.50–3.00	. . .	0.10–0.30	. . .	0.20–0.40	0.10–0.30	. . .	. . .		
TPXM-10	S21900	0.08	8.0–10.0	0.045	0.030	1.00	19.0–21.5	5.5–7.5	. . .	. . .	. . .	. . .	0.15–0.40	. . .	. . .	. . .		
TPXM-11	S21904	0.04	8.0–10.0	0.045	0.030	1.00	19.0–21.5	5.5–7.5	. . .	. . .	. . .	. . .	0.15–0.40	. . .	. . .	. . .		
TPXM-29	S24000	0.08	11.5–14.5	0.060	0.030	1.00	17.0–19.0	2.3–3.7	. . .	. . .	. . .	. . .	0.20–0.40	. . .	. . .	. . .		
TP304	S30400	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
TP304L	S30403	0.035[D]	2.00	0.045	0.030	1.00	18.0–20.0	8.0–13.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
TP304H	S30409	0.04–0.10	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
. . .	S30415	0.04-0.06	0.80	0.045	0.030	1.00–2.00	18.0–19.0	9.0–10.0	. . .	. . .	. . .	. . .	0.12–0.18	. . .	. . .	0.03–0.08		
TP304N	S30451	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–18.0	. . .	. . .	. . .	. . .	0.10–0.16	. . .	. . .	. . .		
TP304LN	S30453	0.035	2.00	0.045	0.030	1.00	18.0–20.0	8.0–12.0	. . .	. . .	. . .	. . .	0.10–0.16	. . .	. . .	. . .		
. . .	S30600	0.018	2.00	0.02	0.02	3.7–4.3	17.0–18.5	14.0–15.5	0.20	. . .	. . .	. . .	. . .	. . .	0.50 max	. . .		
. . .	S30615	0.16–0.24	2.00	0.030	0.03	3.2-4.0	17.0–19.5	13.5–16.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.80–1.50
. . .	S30815	0.05–0.10	0.80	0.040	0.030	1.40–2.00	20.0–22.0	10.0–12.0	. . .	. . .	. . .	. . .	0.14–0.20	. . .	. . .	0.03–0.08		
TP309S	S30908	0.08	2.00	0.045	0.030	1.00	22.0–24.0	12.0–15.0	0.75	. . .	. . .	. . .	. . .	. . .		. . .		
TP309H	S30909	0.04–0.10	2.00	0.045	0.030	1.00	22.0–24.0	12.0–15.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .			
TP309Cb	S30940	0.08	2.00	0.045	0.030	1.00	22.0–24.0	12.0–16.0	0.75	. . .	10 × C min, 1.10 max	. . .	. . .	. . .		. . .		
TP309HCb	S30941	0.04–0.10	2.00	0.045	0.030	1.00	22.0–24.0	12.0–16.0	0.75	. . .	10 × C min, 1.10 max	. . .	. . .	. . .				
	S31002	0.015	2.00	0.020	0.015	0.15	19.0–22.0	24.0–26.0	0.10	. . .	. . .	. . .	0.10	. . .				
TP310S	S31008	0.08	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	0.75	. . .	. . .	. . .	. . .	. . .		. . .		
TP310H	S31009	0.04–0.10	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .			
TP310Cb	S31040	0.08	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	0.75	. . .	10 × C min, 1.10 max	. . .	. . .	. . .		. . .		
TP310HCb	S31041	0.04–0.10	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	0.75	. . .	10 × C min, 1.10 max	. . .	. . .	. . .				
. . .	S31050	0.025	2.00	0.020	0.015	0.4	24.0–26.0	20.5–23.5	1.6–2.6	. . .	. . .	. . .	0.09–0.15	. . .	. . .	. . .		
. . .	S31254	0.020	1.00	0.030	0.010	0.80	19.5–20.5	17.5–18.5	6.0–6.5	. . .	. . .	. . .	0.18–0.22	. . .	0.50–1.00	. . .		
	S31272	0.08–012	1.5–2.00	0.030	0.015	0.25–0.75	14.0–16.0	14.0–16.0	1.00–1.40	0.30–0.60							0.004–0.008	
TP316	S31600	0.08	2.00	0.045	0.030	1.00	16.0–18.0	11.0–14.0[E]	2.00–3.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
TP316L	S31603	0.035[D]	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.00–3.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
TP316H	S31609	0.04–0.10	2.00	0.045	0.030	1.00	16.0–18.0	11.0–14.0[E]	2.00–3.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
. . .	S31635	0.08	2.00	0.045	0.030	0.75	16.0-18.0	10.0-12.0	2.00-3.00	5× (C+N) min, 0.70	. . .	. . .	0.10	. . .	. . .	. . .	. . .	. . .
TP316N	S31651	0.08	2.00	0.045	0.030	1.00	16.0–18.0	11.0–14.0[E]	2.00–3.00				0.10–0.16	. . .	. . .	. . .		
TP316LN	S31653	0.035	2.00	0.045	0.030	1.00	16.0–18.0	11.0–14.0[E]	2.00–3.00	. . .	. . .	. . .	0.10–0.16	. . .	. . .	. . .		
TP317	S31700	0.08	2.00	0.045	0.030	1.00	18.0–20.0	11.0–14.0	3.0–4.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
TP317L	S31703	0.035	2.00	0.045	0.030	1.00	18.0–20.0	11.0–15.0	3.0–4.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
. . .	S31725	0.03	2.00	0.040[F]	0.030	1.00	18.0–20.0	13.5–17.5	4.0–5.0	. . .	. . .	. . .	0.10	. . .	0.75	. . .		
. . .	S31726	0.03	2.00	0.040[F]	0.030	1.00	17.0–20.0	14.5–17.5	4.0–5.0	. . .	. . .	. . .	0.10–0.20	. . .	0.75	. . .		
TP321	S32100	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	. . .	[G]	. . .	. . .	0.10	. . .	. . .	. . .		
TP321H	S32109	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	. . .	[H]	. . .	. . .	. . .	. . .	. . .	. . .		

TABLE 1 *Continued*

Grade	UNS Designation[A]	Composition, %[B]															
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Titanium	Columbium	Tantalum, max	Nitrogen[C]	Vanadium	Copper	Cerium	Boron	Aluminum
. . .	S32615	0.07	2.00	0.045	0.030	4.8–6.0	16.5–19.5	19.0–22.0	0.30–1.50	. . .	. . .	. . .	. . .	. . .	1.50–2.50	. . .		
. . .	S32654	0.020	2.0–4.0	0.030	0.005	0.50	24.0–25.0	21.0–23.0	7.0–8.0	. . .	. . .	. . .	0.45–0.55	. . .	0.30–0.60	. . .		
. . .	S33228	0.04–0.08	1.00	0.020	0.015	0.30	26.0–28.0	31.0–33.0	. . .	. . .	0.60–1.00	. . .	. . .	. . .	. . .	0.05–0.10	. . .	0.025
. . .	S34565	0.03	5.0–7.0	0.030	0.010	1.00	23.0–25.0	16.0–18.0	4.0–5.0	. . .	0.10		0.40–0.60	. . .	. . .	. . .	. . .	
TP347	S34700	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[I]	. . .	. . .	. . .	. . .	. . .		
TP347H	S34709	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[J]	. . .	. . .	. . .	. . .	. . .		
TP347LN	S34751	0.005–0.020	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	0.20–0.50[F,K]	. . .	0.06–0.10	. . .	. . .	. . .	. . .	. . .
TP348	S34800	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[I]	0.10	. . .	. . .	. . .	. . .		
TP348H	S34809	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[J]	0.10	. . .	. . .	. . .	. . .		
. . .	S35045	0.06-0.10	1.50	. . .	0.015	1.00	25.0-29.0	32.0-37.0	. . .	0.15-0.60	. . .	. . .	. . .	. . .	0.75	. . .	. . .	0.15-0.60
. . .	S35315	0.04–0.08	2.00	0.040	0.030	1.20–2.00	24.0–26.0	34.0–36.0	. . .	. . .	. . .	. . .	0.12–0.18	. . .	. . .	0.03–0.08	. . .	. . .
TPXM-15	S38100	0.08	2.00	0.030	0.030	1.50–2.50	17.0–19.0	17.5–18.5	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
. . .	N08367	0.030	2.00	0.040	0.030	1.00	20.0–22.0	23.5–25.5	6.0–7.0	. . .	. . .	. . .	0.18–0.25	. . .	0.75	. . .	. . .	. . .
. . .	N08904	0.020	2.00	0.040	0.030	1.00	19.0–23.0	23.0–28.0	4.0–5.0	. . .	. . .	. . .	0.10	. . .	1.00–2.00	. . .	. . .	. . .
. . .	N08926	0.020	2.00	0.030	0.010	0.50	24.0–26.0	19.0–21.0	6.0–7.0	. . .	. . .	. . .	0.15–0.25	. . .	0.50–1.50	. . .	. . .	. . .

[A] New designation established in accordance with Practice E 527 and SAE J1086.
[B] Maximum, unless otherwise indicated.
[C] The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.
[D] For small diameter or thin walls or both, where many drawing passes are required, a carbon maximum of 0.040 % is necessary in grades TP304L and TP316L. Small outside diameter tubes are defined as those less than 0.500 in. [12.7 mm] in outside diameter and light wall tubes as those less than 0.049 in. [1.20 mm] in average wall thickness (0.044 in. [1.10 mm] in minimum wall thickness).
[E] For welded TP316, TP316N, TP316LN, and TP316H pipe, the nickel range shall be 10.0–14.0 %.
[F] For welded pipe, the phosphorus maximum shall be 0.045 %.
[G] The titanium content shall be not less than five times the carbon content and not more than 0.70 %.
[H] The titanium content shall be not less than four times the carbon content and not more than 0.60 %.
[I] The columbium content shall be not less than ten times the carbon content and not more than 1.00 %.
[J] The columbium content shall be not less than eight times the carbon content and not more than 1.0 %.
[K] Grade S34751 shall have a columbium (niobium) plus tantalum content of not less than 15 times the carbon content.

TABLE 2 Chemical Requirements

NOTE 1—Where an ellipsis (...) appears in this table, there is no requirement.

Grade[A]			Composition, %										
Grade WP	Grade CR	UNS Designation	C[B]	Mn[B]	P[B]	S[B]	Si[B]	Ni	Cr	Mo	Ti	N_2C[C]	Others
WPXM-19	CRXM-19	S20910	0.06	4.0–6.0	0.045	0.030	1.00	11.5–13.5	20.5–23.5	1.50–3.00	. . .	0.20–0.40	[D]
WP304	CR304	S30400	0.08	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	. . .	. . .	. . .	. . .
WP304L	CR304L	S30403	0.030[E]	2.00	0.045	0.030	1.00	8.0–12.0	18.0–20.0	. . .	. . .	. . .	. . .
WP304H	CR304H	S30409	0.04–0.10	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	. . .	. . .	. . .	. . .
WP304N	CR304N	S30451	0.08	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	. . .	. . .	0.10–0.16	. . .
WP304LN	CR304LN	S30453	0.030	2.00	0.045	0.030	1.00	8.0–11.0	18.0–20.0	. . .	. . .	0.10–0.16	. . .
WP309	CR309	S30900	0.20	2.00	0.045	0.030	1.00	12.0–15.0	22.0–24.0	. . .	. . .	. . .	. . .
WP310S	CR310S	S31008	0.08	2.00	0.045	0.030	1.00	19.0–22.0	24.0–26.0	. . .	. . .	. . .	. . .
WPS31254	CRS31254	S31254	0.020	1.00	0.030	0.010	0.80	17.5–18.5	19.5–20.5	6.0–6.5	. . .	0.18–0.22	Cu 0.50–1.00
WP316	CR316	S31600	0.08	2.00	0.045	0.030	1.00	10.0–14.0	16.0–18.0	2.00–3.00	. . .	. . .	. . .
WP316L	CR316L	S31603	0.030[E]	2.00	0.045	0.030	1.00	10.0–14.0[F]	16.0–18.0	2.00–3.00	. . .	. . .	. . .
WP316H	CR316H	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	. . .	. . .	. . .
WP316N	CR316N	S31651	0.08	2.00	0.045	0.030	1.00	10.0–13.0	16.0–18.0	2.00–3.00	. . .	0.10-0.16	. . .
WP316LN	CR316LN	S31653	0.030	2.00	0.045	0.030	1.00	10.0–13.0	16.0–18.0	2.00–3.00	. . .	0.10–0.16	. . .
WP317	CR317	S31700	0.08	2.00	0.045	0.030	1.00	11.0–15.0	18.0–20.0	3.0–4.0	. . .	. . .	. . .
WP317L	CR317L	S31703	0.030	2.00	0.045	0.030	1.00	11.0–15.0	18.0–20.0	3.0–4.0	. . .	. . .	. . .
WPS31725	CRS31725	S31725	0.030	2.00	0.045	0.030	1.00	13.5–17.5	18.0–20.0	4.0–5.0	. . .	0.20	. . .
WPS31726	CRS31726	S31726	0.030	2.00	0.045	0.030	1.00	13.5–17.5	17.0–20.0	4.0–5.0	. . .	0.10–0.20	. . .
WP321	CR321	S32100	0.08	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	. . .	[G]	. . .	. . .
WP321H	CR321H	S32109	0.04–0.10	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	. . .	[H]	. . .	. . .
WPS33228	CRS33228	S33228	0.04–0.08	1.00	0.020	0.015	0.30	31.0–33.0	26.0–28.0	. . .	. . .	. . .	Ce 0.05–0.10 Al 0.025 Cb 0.6–1.0
WPS34565	CRS34565	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	. . .	0.40–0.60	Cb 0.10
WP347	CR347	S34700	0.08	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	. . .	. . .	. . .	[I]
WP347H	CR347H	S34709	0.04–0.10	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	. . .	. . .	. . .	[J]
WP348	CR348	S34800	0.08	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	. . .	. . .	. . .	Cb+Ta=10×(C)−1.10 Ta 0.10 Co 0.20
WP348H	CR348H	S34809	0.04–0.10	2.00	0.045	0.030	1.00	9.0–12.0	17.0–19.0	. . .	. . .	. . .	Cb+Ta=8×(C)−1.10 Ta 0.10 Co 0.20

[A] See Section 15 for marking requirements.
[B] Maximum, unless otherwise indicated.
[C] The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.
[D] Columbium 0.10–0.30 %; Vanadium, 0.10–0.30 %.
[E] For small diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040 % is necessary in grades TP304L and TP316L. Small outside diameter tubes are defined as those less than 0.500 in. [12.7 mm] in outside diameter and light wall tubes as those less than 0.049 in. [1.24 mm] in average wall thickness.
[F] On pierced tubing, the nickel may be 11.0–16.0 %.
[G] $5X(C+N_2)$–0.70.
[H] $4X(C+N_2)$–0.70.
[I] The columbium content shall be not less than ten times the carbon content and not more than 1.10 %.
[J] The columbium content shall be not less than eight times the carbon content and not more than 1.10 %.

Section VIII, Division I, of the ASME Boiler and Pressure Vessel Code.

5.12 Fittings machined from bar shall be restricted to NPS 4 or smaller. Elbows, return bends, tees, and header tees shall not be machined directly from bar stock.

5.12.1 All caps machined from bar shall be examined by liquid penetrant in accordance with Supplementary Requirement S52 in Specification A 960.

5.13 Weld buildup is permitted to dimensionally correct unfilled areas produced during cold forming of stub ends. Radiographic examination of the weld buildup shall not be required provided that all the following steps are adhered to:

5.13.1 The weld procedure and welders or welding operators meet the requirements of 5.10.

5.13.2 Annealing is performed after welding and prior to machining.

5.13.3 All weld surfaces are liquid penetrant examined in accordance with Appendix 8 of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

5.13.4 Repair of areas in the weld is permitted, but 5.13.1, 5.13.2, and 5.13.3 must be repeated.

5.14 Stub ends may be produced with the entire lap added as weld metal to a straight pipe section provided the welding satisfies the requirements of 5.10 for qualifications and 6.3 post weld heat treatment.

5.14.1 *Grade WP Class W*— Radiographic inspection of the weld is required. See 5.4.

5.14.2 *Grade WP Class WX*—Radiographic inspection of all welds is required. See 5.5.

5.14.3 *Grade WP Class WU*—Ultrasonic inspection of all welds is required. See 5.6.

5.14.4 *Grade CR*—Nondestructive examination is not required. See 5.12.1.

5.15 Stub ends may be produced with the entire lap added by the welding of a ring, made from plate or bar of the same alloy grade and composition, to the outside of a straight section of pipe, provided the weld is double welded, is a full

High Performance Austenitic Stainless Steel

Steel grades

Outokumpu	EN	ASTM
904L	1.4539	N08904
254 SMO®	1.4547	S31254
4565	1.4565	S34565

Characteristic properties

- Austenitic structure
- Very good resistance to uniform corrosion
- Good to exceptionally good resistance to pitting and crevice corrosion
- Very good resistance to various types of stress corrosion cracking
- Good ductility
- Good weldability

Applications

- Process equipment in chemical industry
- Bleaching equipment in the pulp and paper industry
- Flue gas cleaning
- Desalination
- Seawater handling
- Heat exchangers

General characteristics

High performance austenitic stainless steels differ substantially from more conventional grades with regard to resistance to corrosion and, in some cases, also mechanical and physical properties. This is mainly due to the high contents of chromium, nickel, molybdenum and nitrogen.
From a fabrication viewpoint, i.e., with regard to manufacturing of components and equipment, they are to some extent similar to standard austenitic grades such as 1.4301 and 1.4401, but they still require special know-how with regard to welding and machining.

Outokumpu Stainless manufactures a numbers of steels of this type: 904L, 254 SMO and 4565. 4529 can also be delivered if specified. The properties of 4529 are in general terms very similar to those of 254 SMO.

In certain applications the grades 4439 (austenitic) and 2205 (duplex) may be used as an alternative to 904L, whilst SAF 2507 (duplex) may be used as an alternative to 254 SMO. More information concerning duplex options is available in the data sheet for duplex steels.

Chemical composition

The chemical composition of a steel grade may vary slightly between different national standards. Consequently, a specified standard should always be stated when ordering.

Chemical composition Table 1

Outokumpu steel name	International steel No		Chemical composition, % typical values						National steel designations, superseded by EN			
	EN	ASTM	C	N	Cr	Ni	Mo	Others	BS	DIN	NF	SS
2205	1.4462	S32205*	0.02	0.17	22	5.7	3.1	–	318S13	1.4462	Z3 CND 22-05 Az	2377
SAF 2507®	1.4410	S32750	0.02	0.27	25	7	4	–	–	–	Z3 CND 25-06 Az	2328
4436	1.4436	316	0.03	–	16.9	10.7	2.6	–	316S33	1.4436	Z7 CND 18-12-03	2343
4439	1.4439	S31726	0.02	0.14	17.8	12.7	4.1	–	–	1.4439	Z3 CND 18-14-05 Az	–
4529	1.4529	N08926	0.01	0.20	20	25	6.4	Cu	–	1.4529	–	–
904L	1.4539	N08904	0.01	–	20	25	4.3	1.5 Cu	904S13	1.4539	Z2 NCDU 25-20	2562
254 SMO®	1.4547	S31254	0.01	0.20	20	18	6.1	Cu	–	–	–	2378
4565	1.4565	S34565	0.02	0.45	24	18	4,5	6 Mn	–	1.4565	–	–

* Also available as S31803