

PMI Acceptance/Rejection Criteria

Materials requiring PMI shall be analyzed to the extent necessary to confirm the individual alloy elements listed in Appendix D—Key Elements.

a. Base materials shall be acceptable if the individual elements listed in Appendix D—Key Elements—are within the ranges permitted by ASME BPVC, Section II, Part A and B, or the Annual Book of ASTM Standards, Sections 1 and 2, plus/minus tolerance of the equipment (analyzer).

b. Weld deposits shall be acceptable if the individual elements listed in are within the ranges permitted by ASME BPVC, Section II, Part C, for the applicable welding consumable plus/minus tolerance of the equipment (analyzer).

c. Results from testing dissimilar metal weld, weld overlay and back-cladding welds shall take into account the effects of dilution, which occurs during weld deposition. If the minimum compositional requirements of the as-deposited weld metal do not meet the required specification (as outlined in ASME BPVC, Section II, Part C – Specifications for Welding Rods, Electrodes and Filler Metals), then a CPChem Materials Engineer shall confirm whether the weldment will perform satisfactorily in the intended service.

d. Acceptance or rejection shall take into account the accuracy of the testing equipment used. Accuracy tolerances can vary from one test equipment manufacturer to another. The individual manufacturer's accuracy tolerance shall be consulted when determining acceptance or rejection.

e. If PMI test results fall outside the acceptable ranges including the product analysis tolerances in the applicable "Reference Documents" covering "General Requirements", the material shall be replaced or a chemical analysis shall be conducted by an independently accredited or Owner-accepted testing laboratory. Results of this laboratory chemical analysis shall govern.

Appendix D

KEY ELEMENTS (Page 1 of 2)

Alloy Material	UNS#	Pipe Spec	Key Elements	Cr	Mn	Fe	Ni	Cu	Nb	Mo	Ti	Zn	Other
C-Mo	K11552	A335 Gr P1	Mo							0.44-0.65			
1 Cr-1/2 Mo	K11562	A335 Gr P12	Cr; Mo	0.8-1.25						0.44-0.65			
1 ¼ Cr-1/2 Mo		A335 Gr P11	Cr; Mo	1.0-1.5						0.44-0.65			
2 ¼ Cr-1 Mo	K11597	A335 Gr P22	Cr; Mo	1.9-2.6						0.87-1.13			
5 Cr-1/2 Mo	K21590	A335 Gr P5	Cr; Mo	4.0-6.0						0.45-0.65			
9 Cr-1 Mo	K41545	A335 Gr P9	Cr; Mo	8.0-10.0						0.9-1.10			
9 Cr-1 Mo 0.2 V	S50400	A335 Gr P91	Cr; Mo	8.0-9.5						0.85-1.05			0.18-0.25 V
9 Cr-1/2 Mo 0.2 V 2 W	K91560	A335 Gr P92	Cr; Mo; V	8.5-9.5						0.30-0.60			0.15-0.25 V 1.5-2.0 W
B7 (AISI 4140)				0.8-1.10						0.15-0.25			
B16 (AISI4140)				0.8-1.15						0.5-0.65			0.25-0.35 V
Ferritic and Martensitic Stainless Steels													
Type 405	S40500	A268 TP405	Cr	11.5-14.5									
Type 410	S41000	A268 TP410	Cr	11.5-13.5									
Austenitic Stainless Steels													
Type 304	S30400	A312 TP304	Cr; Ni	18.0-20.0			8.0-11.0						
Type 309	S30900	A358 Gr309	Cr; Ni	22.0-24.0			12.0-15.0						
Type 310	S31000	A358 Gr310	Cr; Ni	24.0-26.0			19.0-22.0						
Type 316	S31600	A312 TP316	Cr; Ni; Mo	16.0-18.0			11.0-14.0			2.0-3.0			
Type 317	S31700	A312 TP317	Cr; Ni; Mo	18.0-20.0			11.0-15.0			3.0-4.0			
Type 321	S32100	A312 TP321	Cr; Ni; Ti	17.0-19.0			9.0-12.0				0.1-0.7		
Type 347	S34700	A312 TP347	Cr; Ni; Nb	17.0-19.0			9.0-13.0		0.8-1.0				
Cast Austenitic CF8M	J92900	A351 CF8M	Cr; Ni; Mo	18.0-21.0			9.0-12.0			2.0-3.0			

KEY ELEMENTS (Page 2 of 2)

Alloy Material	UNS#	Pipe Spec	Key Elements	Cr	Mn	Fe	Ni	Cu	Nb	Mo	Ti	Zn	Other
Duplex Stainless Steels													
Wrought Duplex 31803	S31803	A182/A815	Cr, Ni, Mo, Cu	21.0-23.0			4.5-6.5			2.5-3.5			
Wrought Duplex 32205	S32205	A182/A815	Cr, Ni, Mo, Cu	22.0-23.0			4.5-6.5			3.0-3.5			
Wrought Super Duplex 32750	S32750	A182/A815	Cr, Ni, Mo, Cu	24.0-26.0			6.0-8.0	0.5		3.0-5.0			
Cast Duplex CD3MN	J92205	A995	Cr, Ni, Mo, Cu	21.0-23.5			4.5-6.5	≤1.0		2.5-3.5			
Cast Super Duplex CE3MN	J93404	A995	Cr, Ni, Mo	24.0-26.0			6.0-8.0			4.0-5.0			
Cast Duplex CD4M/CuN	J93372	A995	Cr, Ni, Mo, Cu	24.5-26.5			4.7-6.0	2.7-3.3		1.7-2.3			
Nickel Based Alloys													
Nickel 200	N02200	B161	Ni				≥99.0						
Incoloy 800	N08800	B407	Ni	19.0-23.0			30.0-35.0						
Incoloy 800H	N08810	B407	Ni, Cr, Al, Ti	19.0-23.0			30.0-35.0				0.15-0.6		
Incoloy 825	N08825	B423	Ni, Cr, Mo, Cu, Ti	19.5-23.5			38.0-46.0	1.5-3.0		2.5-3.5	0.6-1.2		
Inconel 600	N06600	B167	Ni, Cr, Fe	14.0-17.0		6.0-10.0	≥72.0						
Inconel 625	N06625	B444	Ni, Cr, Mo, Nb, Ti	20.0-23.0			≥58.0		3.15-4.15	8.0-10.0	≤0.4		≤0.4 Al
Hastelloy Alloy B-2	N10665	B622	Ni, Fe, Mo				REM			26.0-30.0			
Hastelloy Alloy C-276	N10276	B622	Ni, Cr, Mo, Fe, W	14.5-16.5		4.0-7.0	REM			15.0-17.0			3.0-4.5 W
Hastelloy Alloy C-22	N06022	B622	Ni, Cr, Fe, Mo	20.0-22.5		2.0-6.0	REM			12.5-14.5			≤2.5 Co 2.5-3.5 W
Hastelloy Alloy C-2000	N06200	B622	Ni, Cr, Fe, Mo, Cu	22.0-24.0		≤3.0	REM	1.3-1.9		15.0-17.0			
Hastelloy G	N06007	B622	Ni, Cr, Fe, Mo, Nb, Cu	21.0-23.5		18.0-21.0	REM	1.5-2.5	1.75-2.5	5.5-7.5			
Carpenter Alloy 20-CB3	N08020	B464	Ni, Cr, Mo, Cu, Nb	19.0-21.0			32.0-38.0	3.0-4.0	0.0-1.0	2.0-3.0			
Cast Alloy CN7M	N08007	A351	Ni, Cr, Mo, Cu	19.0-22.0			27.5-30.5	3.0-4.0		2.0-3.0			
Monel 400	N04400	B165	Ni, Cu				≥63	28.0-34.0					
Aluminum Alloys													
Alloy 3003 Aluminum	A93003	B241			1.0-1.5			0.05-0.2					REM Al
Alloy 6061 Aluminum	A96061	B241		0.04-0.35	≤0.15			0.15-0.4			≤0.15		REM Al
Copper Alloys													
Admiralty Brass	C44300	B111/B171	Cu, Zn, Sn			≤0.06		70.0-73.0				REM	0.9-1.2 Sn
90-10 Copper-Nickel	C70600	B111/B171	Cu, Ni		≤1.0	1.0-1.8	9.0-11.0	REM				≤1.0	
70-30 Copper-Nickel	C71500	B111/B171	Cu, Ni		≤1.0	0.4-1.0	29.0-33.0	REM				≤1.0	

Appendix C

MARKING FOR MATERIAL IDENTIFICATION (Page 1 of 2)

Materials	Designation	UNS Number	Color Coding	Key Alloy Elements
Low Alloy Materials				
C-1/2 Mo	A335 Gr P1	K11522	1 Solid Orange	Mo
1 Cr-1/2 Mo	A335 Gr. P12	K11562	1 Solid Orange, 1 Solid Blue	Cr; Mo
1 1/4Cr-1/2 Mo	A335 Gr. P11	K11597	1 Solid Yellow	Cr; Mo
2 1/4Cr-1 Mo	A335 Gr P22	K21590	1 Solid Blue	Cr; Mo
5 Cr-1/2 Mo	A335 Gr P5	K41545	1 Solid Blue, 1 Solid Yellow	Cr; Mo
9 Cr-1 Mo	A335 Gr P9	K90941	2 Solid Orange	Cr; Mo
9 Cr-1 Mo 0.2 V	A335 Gr P91	K90901	1 Solid Pink, 1 Solid Gray	Cr; Mo
Austenitic Stainless Steels*				
Type 304	A312 TP304	S30400	1 Solid Black	Cr; Ni
Type 304L	A312 TP304L	S30403	2 Solid Black	Cr; Ni
Type 304H	A312 TP304H	S30409	1 Intermittent Black	Cr; Ni
Type 309	A358 Gr309	S30900	1 Solid Black, 1 Solid Brown	Cr; Ni
Type 310	A358 Gr310	S31000	1 Solid Green, 1 Solid Orange	Cr; Ni
Type 316	A312 TP316	S31600	2 Solid Yellow	Cr; Ni; Mo
Type 316L	A312 TP316L	S31603	1 Solid Green	Cr; Ni; Mo
Type 316H	A312 TP316H	S31609	1 Intermittent Green	Cr; Ni; Mo
Type 317	A312 TP317	S31700	1 Solid Brown, 1 Solid Green	Cr; Ni; Mo
Type 317L	A312 TP317L	S31703	1 Solid Brown, 1 Solid Red	Cr; Ni; Mo
Type 321	A312 TP321	S32100	1 Solid Pink	Cr; Ni; Ti
Type 321H	A312 TP321H	S32109	2 Solid Pink	Cr; Ni; Ti
Type 347	A312 TP347	S34700	1 Solid Brown	Cr; Ni; Nb
Type 347H	A312 TP347H	S34709	2 Solid Brown	Cr; Ni; Nb

Material Verification Program for Alloy Materials

MARKING FOR MATERIAL IDENTIFICATION (Page 2 of 2)

Materials	Designation	UNS Number	Color Coding	Key Alloy Elements
Duplex Stainless Steels*				
Duplex 2205	A790 Gr 2205	S31803	2 Solid Green	Cr; Ni; Mo; N
Duplex 2507	A790 Gr 2507	S32750	2 Solid Purple	Cr; Ni; Mo; N
Nickel Based Alloys*				
Nickel 200	B161	N02200	1 Solid Black, 1 Solid Pink	Ni
Incoloy 800	B407	N08800	1 Solid Black, 1 Solid Orange	Ni; Cr; Al; Ti
Incoloy 800H	B407	N08810	1 Solid Green, 1 Solid Red	Ni; Cr; Al; Ti
Incoloy 825	B423	N08825	1 Solid Green, 1 Solid Blue	Ni; Cr; Mo; Cu; Ti
Inconel 600	B167	N06600	2 Solid Blue	Ni; Cr
Inconel 625	B444	N06625	1 Solid Blue, 1 Solid Pink	Ni; Cr; Mo; Nb; Ti
Hastelloy B-2	B622	N10665	1 Solid Red, 1 Solid Orange	Ni; Mo; Fe
Hastelloy C-276	B622	N10276	1 Solid Red, 1 Solid Blue	Ni; Cr; Mo; Fe; Ti
Hastelloy C-22	B622	N06022	2 Solid Red	Ni; Cr; Mo
Hastelloy G	B622	N06007	1 Solid Red, 1 Solid Yellow	Ni; Cr; Fe; Mo
Alloy 20 CB-3	B464	N08020	1 Solid Black, 1 Solid Blue	Cr; Ni; Mo; Nb; Cu;
Monel 400	B165	N04400	1 Solid Black, 1 Solid Yellow	Ni; Cu
Aluminum Alloys				
Alloy 3003	B241	A93003	1 Solid Purple	Al; Mn; Cu
Alloy 6061	B241	A96061	1 Solid Tan	Al; Mg; Si; Cu

Any product manufactured by welding shall have an additional white stripe.

* Stenciling and color coding shall be done with a water-insoluble material that does not contain harmful substances (e.g., metallic pigments aluminum, lead, zinc, sulfur, chlorides), which would attack or harmfully affect austenitic or nickel alloy steels at ambient or elevated temperatures. Fittings (elbows, tee, etc.) shall be color-coded the full length.