

# MMPDS-11 Table of Contents

## Chapter 2 - Steel Alloys

Foreword . . . . .	.i
Explanation of Numerical Code . . . . .	iii
Registered Trademarks . . . . .	v
CHAPTER 2 STEEL ALLOYS . . . . .	2-1
2.1 GENERAL. . . . .	2-1
2.1.1 ALLOY INDEX . . . . .	2-1
2.1.2 MATERIAL PROPERTIES. . . . .	2-2
2.1.2.1 Mechanical Properties. . . . .	2-3
2.1.2.2 Physical Properties . . . . .	2-6
2.1.3 ENVIRONMENTAL CONSIDERATIONS . . . . .	2-9
2.1.4 OBSOLETE ALLOYS, HEAT TREATMENTS, AND PRODUCT FORMS . . . . .	2-9
2.2 CARBON STEELS . . . . .	2-13
2.2.0 COMMENTS ON CARBON STEELS . . . . .	2-13
2.2.0.1 Metallurgical Considerations . . . . .	2-13
2.2.0.2 Manufacturing Considerations . . . . .	2-13
2.2.0.3 Environmental Considerations . . . . .	2-14
2.2.1 AISI 1025 . . . . .	2-15
2.2.1.0 Comments and Properties . . . . .	2-15
2.3 LOW-ALLOY STEELS (AISI GRADES AND PROPRIETARY GRADES). . . . .	2-19
2.3.0 COMMENTS ON LOW-ALLOY STEELS (AISI AND PROPRIETARY GRADES) . . . . .	2-19
2.3.0.1 Metallurgical Considerations . . . . .	2-19
2.3.0.2 Manufacturing Conditions . . . . .	2-19
2.3.0.3 Environmental Considerations . . . . .	2-22
2.3.1 SPECIFIC ALLOYS . . . . .	2-23
2.3.1.0 Comments and Properties . . . . .	2-23
2.3.1.1 AISI Low-Alloy Steels . . . . .	2-23
2.3.1.2 AISI 4130 and 8630 Steels . . . . .	2-23
2.3.1.3 AISI 4340 Steel . . . . .	2-23
2.3.1.4 300M Steel . . . . .	2-23
2.3.1.5 D6AC Steel . . . . .	2-23
2.4 INTERMEDIATE ALLOY STEELS . . . . .	2-75
2.4.0 Comments on Intermediate Alloy Steels . . . . .	2-75
2.4.0.1 Metallurgical Considerations . . . . .	2-75
2.4.1 5CR-MO-V . . . . .	2-75
2.4.1.0 Comments and Properties . . . . .	2-75
2.4.1.1 Heat-Treated Condition . . . . .	2-79
2.4.2 9Ni-4Co-0.20C . . . . .	2-83
2.4.2.0 Comments and Properties . . . . .	2-83
2.4.2.1 Heat-Treated Condition . . . . .	2-85

**MMPDS-11**  
**1 July 2016**

2.4.3 9Ni-4Co-0.30C . . . . .	2-88
2.4.3.0 Comments and Properties . . . . .	2-88
2.4.3.1 Heat-Treated Condition . . . . .	2-90
2.5 HIGH-ALLOY STEELS . . . . .	2-99
2.5.0 COMMENTS ON HIGH-ALLOY STEELS . . . . .	2-99
2.5.0.1 Metallurgical Considerations . . . . .	2-99
2.5.0.2 Environmental Considerations . . . . .	2-99
2.5.1 18 NI MARAGING STEELS . . . . .	2-101
2.5.1.0 Comments and Properties . . . . .	2-101
2.5.1.1 Maraged Condition (aged at 900°F) . . . . .	2-101
2.5.2 AF1410 . . . . .	2-110
2.5.2.0 Comments and Properties . . . . .	2-110
2.5.2.1 Heat-Treated Condition . . . . .	2-112
2.5.3 AERMET 100 . . . . .	2-113
2.5.3.0 Comments and Properties . . . . .	2-113
2.5.3.1 280-300 ksi Heat-Treated Condition . . . . .	2-115
2.5.3.2 290-310 ksi Heat-Treated Condition . . . . .	2-117
2.5.4 FERRIUM S53 . . . . .	2-119
2.5.4.0 Comments and Properties . . . . .	2-119
2.5.4.1 Heat Treated Condition . . . . .	2-122
2.5.5 FERRIUM M54 . . . . .	2-131
2.5.5.0 Comments and Properties . . . . .	2-131
2.5.5.1 Aged at 960°F Condition . . . . .	2-134
2.6 PRECIPITATION- AND TRANSFORMATION-HARDENING STEELS (STAINLESS) . . . . .	2-137
2.6.0 COMMENTS ON PRECIPITATION AND TRANSFORMATION-HARDENING STEELS (STAINLESS) . . . . .	2-137
2.6.0.1 Metallurgical Considerations . . . . .	2-137
2.6.0.2. Manufacturing Considerations . . . . .	2-137
2.6.0.3 Environmental Considerations . . . . .	2-137
2.6.1 AM-350 . . . . .	2-137
2.6.1.0 Comments and Properties . . . . .	2-137
2.6.1.1 SCT 850 Condition . . . . .	2-140
2.6.2 AM-355 . . . . .	2-144
2.6.2.0 Comments and Properties . . . . .	2-144
2.6.2.1 SCT Condition . . . . .	2-148
2.6.3 CUSTOM 450 . . . . .	2-150
2.6.3.0 Comments and Properties . . . . .	2-150
2.6.3.1 H900 Condition . . . . .	2-154
2.6.3.2 H1050 Condition . . . . .	2-158
2.6.4 CUSTOM 455 . . . . .	2-162
2.6.4.0 Comments and Properties . . . . .	2-162
2.6.4.1 H950 Condition . . . . .	2-165

**MMPDS-11**  
**1 July 2016**

2.6.4.2 H1000 Condition . . . . .	.2-170
2.6.5 CUSTOM 465 . . . . .	.2-173
2.6.5.0 Comments and Properties . . . . .	.2-173
2.6.5.1 H950 and H1000 Condition . . . . .	.2-176
2.6.6 PH13-8Mo . . . . .	.2-179
2.6.6.0 Comments and Properties . . . . .	.2-179
2.6.6.1 H950 and H1000 Conditions . . . . .	.2-184
2.6.6.2 Extra-High Toughness H1000 Conditions . . . . .	.2-190
2.6.7 15-5PH . . . . .	.2-198
2.6.7.0 Comments and Properties . . . . .	.2-198
2.6.7.1 Various Heat-Treated Conditions . . . . .	.2-203
2.6.7.2 H1025 Condition . . . . .	.2-206
2.6.7.3 H1150 Condition . . . . .	.2-211
2.6.8 PH15-7Mo . . . . .	.2-212
2.6.8.0 Comments and Properties . . . . .	.2-212
2.6.8.1 TH1050 Condition . . . . .	.2-215
2.6.9 17-4PH . . . . .	.2-224
2.6.9.0 Comments and Properties . . . . .	.2-224
2.6.9.1 H900 Condition . . . . .	.2-231
2.6.9.2 Various Heat Treat Conditions . . . . .	.2-236
2.6.9.3 H1000 Condition . . . . .	.2-238
2.6.9.4 H1025 Condition . . . . .	.2-239
2.6.9.5 H1100 Condition . . . . .	.2-240
2.6.9.6 H1150 Condition . . . . .	.2-241
2.6.10 17-7PH . . . . .	.2-242
2.6.10.0 Comments and Properties . . . . .	.2-242
2.6.10.1 TH1050 Condition . . . . .	.2-245
2.6.11 HSL180 (12.5CR-1.0 NI-15.5CO-2.0MO) . . . . .	.2-249
2.6.11.0 Comments and Properties . . . . .	.2-249
2.6.11.1 Austenitized and Tempered Condition . . . . .	.2-251
2.6.12 MLX17 . . . . .	.2-256
2.6.12.0 Comments and Properties . . . . .	.2-256
2.6.12.1 H950 Condition . . . . .	.2-259
2.6.12.2 H1000 Condition . . . . .	.2-262
2.6.13 MLX19 . . . . .	.2-265
2.6.13.0 Comments and Properties . . . . .	.2-265
2.6.13.1 H950 Condition . . . . .	.2-268
2.7 AUSTENITIC STAINLESS STEELS . . . . .	.2-271
2.7.0 COMMENTS ON AUSTENITIC STAINLESS STEEL . . . . .	.2-271
2.7.0.1 Metallurgical Considerations . . . . .	.2-271
2.7.0.2 Manufacturing Considerations . . . . .	.2-271
2.7.0.3 Environmental Considerations . . . . .	.2-272
2.7.1 AISI 301 AND RELATED 300 SERIES STAINLESS STEELS . . . . .	.2-273

**MMPDS-11**  
**1 July 2016**

2.7.1.0 Comments and Properties . . . . .	.2-273
2.7.1.1 Solution Heat Treated Condition . . . . .	.2-280
2.7.1.2 ¼ Hard Condition . . . . .	.2-282
2.7.1.3 ½ Hard Condition . . . . .	.2-283
2.7.1.4 ¾ Hard Condition . . . . .	.2-286
2.7.1.5 Full-Hard Condition . . . . .	.2-287
2.8 ELEMENT PROPERTIES . . . . .	.2-293
2.8.1 BEAMS . . . . .	.2-293
2.8.1.1 Simple Beams . . . . .	.2-293
2.8.1.2 Built-Up Beams . . . . .	.2-293
2.8.1.3 Thin-Web Beams . . . . .	.2-293
2.8.2 COLUMNS . . . . .	.2-296
2.8.2.1 General . . . . .	.2-296
2.8.2.2 Effects of Welding . . . . .	.2-296
2.8.3 TORSION. . . . .	.2-297
2.8.3.1 General . . . . .	.2-297
2.8.3.2 Torsion Properties . . . . .	.2-297
REFERENCES . . . . .	.REF-1
 11-APPENDICES	
11-Appendix A - Glossary . . . . .	. A-1
A.1 Abbreviations . . . . .	. A-1
A.2 Symbols . . . . .	. A-5
A.3 Definitions . . . . .	. A-6
C06""Eqpxgtukqp'qh'WUWpksu'qh'O gcuwg'Wugf 'lp'O O RF U'q'UKWpku"*****C/39"	
11-Appendix B - Alloy Index ***** . . . . .	. B-1
11-Appendix C - Specification Index. . . . .	. C-1
11-Appendix D - Testing Standards . . . . .	. D-1
33/Cr gpf kz 'G'ó'Uwdlgev'kf gz . . . . .	*****E-1