

# MMPDS-12 TABLE OF CONTENTS

## MMPDS-12 - Chapter 3

Disclaimer	
Foreword . . . . .	i
Explanation of Numerical Code . . . . .	iii
Trademarks . . . . .	v
Chapter 3 - ALUMINUM . . . . .	3-1
3.1 GENERAL . . . . .	3-1
3.1.1 ALUMINUM ALLOY INDEX . . . . .	3-1
3.1.2 MATERIAL PROPERTIES . . . . .	3-3
3.1.2.1 Mechanical Properties . . . . .	3-4
3.1.2.1.1 Edgewise Bearing . . . . .	3-4
3.1.2.1.2 Clad Sheet and Plate . . . . .	3-5
3.1.2.1.3 Fatigue . . . . .	3-5
3.1.2.1.4 Fracture Toughness . . . . .	3-5
3.1.2.1.5 Cryogenic Temperatures . . . . .	3-16
3.1.2.1.6 Elevated Temperatures . . . . .	3-16
3.1.2.1.7 Stress-Strain Relationships . . . . .	3-16
3.1.2.2 Physical Properties . . . . .	3-30
3.1.2.3 Corrosion Resistance . . . . .	3-30
3.1.2.3.1 Resistance to Stress-Corrosion Cracking . . . . .	3-30
3.1.2.3.2 Resistance to Exfoliation . . . . .	3-38
3.1.3 MANUFACTURING CONSIDERATIONS . . . . .	3-38
3.1.3.1 Avoiding Stress Corrosion Cracking . . . . .	3-38
3.1.3.2 Cold-Formed, Heat-Treatable Aluminum Alloys . . . . .	3-38
3.1.3.3 Dimensional Changes . . . . .	3-38
3.1.3.4 Welding . . . . .	3-39
3.1.4 Obsolete Alloys, Tempers, and Product Forms . . . . .	3-43
3.2 2000 SERIES WROUGHT ALLOYS . . . . .	3-47
3.2.1 2013 ALLOY . . . . .	3-47
3.2.1.0 Comments and Properties . . . . .	3-47
3.2.1.1 T6511 Temper . . . . .	3-49
3.2.2 2014 ALLOY . . . . .	3-64
3.2.2.0 Comments and Properties . . . . .	3-64
3.2.2.1 T6, T62, T651, T652, T6510, and T6511 Temper— . . . . .	3-74
3.2.3 2017 ALLOY . . . . .	3-98

# MMPDS-12 TABLE OF CONTENTS

3.2.3.0 Comments and Properties . . . . .	3-98
3.2.3.1 T4, T451, and T42 Temper . . . . .	3-101
3.2.4 2024 ALLOY . . . . .	3-102
3.2.4.0 Comments and Properties . . . . .	3-102
3.2.4.1 T3, T351, T3510, T3511, T4, and T42 Temper . . . . .	3-122
3.2.4.2 T361 (supersedes T36) Temper . . . . .	3-158
3.2.4.3 T62 and T72 Temper . . . . .	3-158
3.2.4.4 T81, T851, T852, T8510, and T8511 Temper . . . . .	3-165
3.2.4.5 T861 (supersedes T86) Temper . . . . .	3-178
3.2.5 2025 ALLOY . . . . .	3-187
3.2.5.0 Comments and Properties . . . . .	3-187
3.2.6 2026 ALLOY . . . . .	3-190
3.2.6.0 Comments and Properties . . . . .	3-190
3.2.7 2027 ALLOY . . . . .	3-192
3.2.7.0 Comments and Properties . . . . .	3-192
3.2.7.1 T351 Temper . . . . .	3-195
3.2.7.2 T3511 Temper . . . . .	3-199
3.2.27 2029 Alloy . . . . .	3-387
3.2.27.0 Comments and Properties . . . . .	3-387
3.2.27.1 T8 Temper . . . . .	3-390
3.2.8 2050 ALLOY . . . . .	3-201
3.2.8.0 Comments and Properties . . . . .	3-201
3.2.8.1 T84 Temper . . . . .	3-210
3.2.25 2055 ALLOY . . . . .	3-372
3.2.25.0 Comments and Properties . . . . .	3-372
3.2.25.1 T84 Temper . . . . .	3-374
3.2.9 CLAD 2056 ALLOY . . . . .	3-220
3.2.9.0 Comments and Properties . . . . .	3-220
3.2.10 2090 ALLOY . . . . .	3-226
3.2.10.0 Comments and Properties . . . . .	3-226
3.2.10.1 T83 Temper . . . . .	3-228
3.2.11 2098 ALLOY . . . . .	3-229
3.2.11.0 Comments and Properties . . . . .	3-229
3.2.11.1 T82P Temper . . . . .	3-233
3.2.12 2099 ALLOY . . . . .	3-239
3.2.12.0 Comments and Properties . . . . .	3-239
3.2.12.1 T86 Temper . . . . .	3-243
3.2.12.2 T83 Temper . . . . .	3-245

# MMPDS-12 TABLE OF CONTENTS

3.2.12.3 T81 Temper . . . . .	3-251
3.2.13 2124 ALLOY . . . . .	3-253
3.2.13.0 Comments and Properties. . . . .	3-253
3.2.13.1 T851 Temper . . . . .	3-255
3.2.14 2195 ALLOY . . . . .	3-271
3.2.14.0 Comments and Properties. . . . .	3-271
3.2.14.1 T8, T82 Temper . . . . .	3-277
3.2.15 2196 ALLOY . . . . .	3-282
3.2.15.0 Comments and Properties. . . . .	3-282
3.2.15.1 T8511 Temper . . . . .	3-285
3.2.16 2198 ALLOY . . . . .	3-287
3.2.16.0 Comments and Properties. . . . .	3-287
3.2.16.1 T8 Temper . . . . .	3-290
3.2.17 2219 ALLOY . . . . .	3-300
3.2.17.0 Comments and Properties. . . . .	3-300
3.2.17.1 T62 Temper . . . . .	3-307
3.2.17.2 T81 and T851X Tempers . . . . .	3-310
3.2.17.3 T852 Temper . . . . .	3-318
3.2.17.4 T87 Temper . . . . .	3-321
3.2.18 2297 ALLOY . . . . .	3-326
3.2.18.0 Comments and Properties. . . . .	3-326
3.2.18.1 T87 Temper . . . . .	3-329
3.2.28 2395 ALLOY . . . . .	3-397
3.2.28.0 Comments and Properties. . . . .	3-397
3.2.28.1 T84 Temper . . . . .	3-400
3.2.19 2397 ALLOY . . . . .	3-335
3.2.19.0 Comments and Properties. . . . .	3-335
3.2.19.1 T87 Temper . . . . .	3-338
3.2.20 2424 ALLOY . . . . .	3-343
3.2.20.0 Comments and Properties. . . . .	3-343
3.2.21 2519 ALLOY . . . . .	3-346
3.2.21.0 Comments and Properties. . . . .	3-346
3.2.21.1 T87 Temper . . . . .	3-348
3.2.22 2524 ALLOY . . . . .	3-349
3.2.22.0 Comments and Properties. . . . .	3-349
3.2.22.1 T3 Temper . . . . .	3-351
3.2.23 2618 ALLOY . . . . .	3-353
3.2.23.0 Comments and Properties. . . . .	3-353

# MMPDS-12 TABLE OF CONTENTS

3.2.23.1 T61 Temper . . . . .	3-357
3.2.24 2624 ALLOY . . . . .	3-363
3.2.24.0 Comments and Properties. . . . .	3-363
3.2.24.1 T39 Temper . . . . .	3-366
3.2.24.2 T351 Temper . . . . .	3-369
3.2.26 2824 ALLOY . . . . .	3-380
3.2.26.0 Comments and Properties. . . . .	3-380
3.2.26.1 T3511 Temper . . . . .	3-383
3.3 3000 SERIES WROUGHT ALLOYS. . . . .	3-406
3.4 4000 SERIES WROUGHT ALLOYS. . . . .	3-406
3.5 5000 SERIES WROUGHT ALLOYS. . . . .	3-406
3.5.1 5052 ALLOY . . . . .	3-406
3.5.1.0 Comments and Properties . . . . .	3-406
3.5.1.1 O-Temper . . . . .	3-411
3.5.1.2 H32 Temper . . . . .	3-413
3.5.1.3 H34 Temper . . . . .	3-413
3.5.1.4 H36 Temper . . . . .	3-416
3.5.1.5 H38 Temper . . . . .	3-416
3.5.2 5083 ALLOY . . . . .	3-419
3.5.2.0 Comments and Properties . . . . .	3-419
3.5.2.1 O Temper . . . . .	3-424
3.5.3 5086 ALLOY . . . . .	3-426
3.5.3.0 Comments and Properties . . . . .	3-426
3.5.3.1 O Temper . . . . .	3-429
3.5.3.2 H32 Temper . . . . .	3-431
3.5.3.3 H34 Temper . . . . .	3-433
3.5.3.4 H36 Temper . . . . .	3-435
3.5.3.5 H38 Temper . . . . .	3-436
3.5.3.6 H111 Temper . . . . .	3-436
3.5.3.7 H112 Temper . . . . .	3-436
3.5.4 5454 ALLOY . . . . .	3-437
3.5.4.0 Comments and Properties . . . . .	3-437
3.5.4.1 O Temper . . . . .	3-440
3.5.4.2 H32 Temper . . . . .	3-440
3.5.4.3 H34 Temper . . . . .	3-441
3.5.5 5456 ALLOY . . . . .	3-443
3.5.5.0 Comments and Properties . . . . .	3-443

# MMPDS-12 TABLE OF CONTENTS

3.5.5.1 O Temper . . . . .	3-447
3.5.5.2 H111 Temper . . . . .	3-448
3.5.5.3 H112 Temper . . . . .	3-449
3.5.5.4 H321 Temper . . . . .	3-449
3.6 6000 SERIES WROUGHT ALLOYS . . . . .	3-451
3.6.1 6013 ALLOY . . . . .	3-451
3.6.1.0 Comments and Properties . . . . .	3-451
3.6.1.1 T6 Temper . . . . .	3-453
3.6.2 6061 ALLOY . . . . .	3-454
3.6.2.0 Comments and Properties . . . . .	3-454
3.6.2.1 T4, T42, T451, T4510, and T4511 Tempers. . . . .	3-466
3.6.2.2 T6, T62, T651, T652, T6510, and T6511 Tempers . . . . .	3-466
3.6.3 6151 ALLOY . . . . .	3-483
3.6.3.0 Comments and Properties . . . . .	3-483
3.6.3.1 T6 Temper . . . . .	3-483
3.6.4 6156 ALLOY . . . . .	3-486
3.6.4.0 Comments and Properties . . . . .	3-486
3.6.4.1 T62 Temper . . . . .	3-488
3.7 7000 SERIES WROUGHT ALLOYS . . . . .	3-491
3.7.1 7010 ALLOY . . . . .	3-491
3.7.1.0 Comments and Properties . . . . .	3-491
3.7.1.1 T7451 Temper . . . . .	3-494
3.7.1.2 T7651 Temper . . . . .	3-497
3.7.2 7037 ALLOY . . . . .	3-499
3.7.2.0 Comments and Properties . . . . .	3-499
3.7.2.1 T7452 Temper . . . . .	3-502
3.7.3 7040 ALLOY . . . . .	3-508
3.7.3.0 Comments and Properties . . . . .	3-508
3.7.4 7049/7149 ALLOY . . . . .	3-512
3.7.4.0 Comments and Properties . . . . .	3-512
3.7.4.1 T73 and T73511 Tempers . . . . .	3-517
3.7.5 7050 ALLOY . . . . .	3-529
3.7.5.0 Comments and Properties . . . . .	3-529
3.7.5.1 T73510 and T73511 Tempers. . . . .	3-540
3.7.5.2 T74, T7451, and T7452 Tempers . . . . .	3-544
3.7.5.3 T76510 and T76511 Tempers. . . . .	3-576
3.7.6 7055 ALLOY . . . . .	3-581
3.7.6.0 Comments and Properties . . . . .	3-581

# MMPDS-12 TABLE OF CONTENTS

3.7.6.1 T74511 Temper . . . . .	3-586
3.7.6.2 T76511 Temper . . . . .	3-593
3.7.6.3 T7751 and T77511 Tempers . . . . .	3-593
3.7.7 7056 ALLOY . . . . .	3-596
3.7.7.0 Comments and Properties . . . . .	3-596
3.7.7.1 T7651 Temper . . . . .	3-599
3.7.20 7065 ALLOY . . . . .	3-850
3.7.20.0 Comments and Properties. . . . .	3-850
3.7.20.1 T7451 Temper . . . . .	3-855
3.7.20.2 T7651 Temper . . . . .	3-862
3.7.8 7068 ALLOY . . . . .	3-603
3.7.8.0 Comments and Properties . . . . .	3-603
3.7.8.1 T6511 Temper . . . . .	3-605
3.7.9 7075 ALLOY . . . . .	3-610
3.7.9.0 Comments and Properties . . . . .	3-610
3.7.9.1 T6, T651, T652, T6510, T6511 Temper . . . . .	3-632
3.7.9.2 T73, T7351, T7352, T73510, T73511 Tempers . . . . .	3-668
3.7.10 7085 ALLOY . . . . .	3-686
3.7.10.0 Comments and Properties. . . . .	3-686
3.7.10.1 T7451 Temper . . . . .	3-694
3.7.10.2 T7651 Temper . . . . .	3-696
3.7.10.3 T7452 Temper . . . . .	3-698
3.7.11. 7136 ALLOY . . . . .	3-718
3.7.11.0. Comments and Properties . . . . .	3-718
3.7.11.1 T73511 Tempers . . . . .	3-724
3.7.11.2 T74511 Tempers . . . . .	3-732
3.7.11.3. T76511 Temper . . . . .	3-741
3.7.12 7140 ALLOY . . . . .	3-746
3.7.12.0 Comments and Properties. . . . .	3-746
3.7.12.1 T7451 Temper . . . . .	3-750
3.7.12.2 T7651 Temper . . . . .	3-753
3.7.13 7150 ALLOY . . . . .	3-761
3.7.13.0 Comments and Properties. . . . .	3-761
3.7.13.1 T6151 and T61511 Tempers. . . . .	3-767
3.7.13.2 T7751 and T77511 Tempers. . . . .	3-769
3.7.14 7175 ALLOY . . . . .	3-774
3.7.14.0 Comments and Properties. . . . .	3-774
3.7.14.1 T73511 Temper . . . . .	3-779

# MMPDS-12 TABLE OF CONTENTS

3.7.14.2 T74 and T7452 Tempers . . . . .	3-784
3.7.15 7249 ALLOY . . . . .	3-789
3.7.15.0 Comments and Properties. . . . .	3-789
3.7.15.1 T7452 Temper . . . . .	3-793
3.7.15.2 T76511 Temper . . . . .	3-795
3.7.16 7255 ALLOY . . . . .	3-797
3.7.16.0 Comments and Properties. . . . .	3-797
3.7.16.1 T7751 Temper . . . . .	3-799
3.7.17 7349 ALLOY . . . . .	3-801
3.7.17.0 Comments and Properties. . . . .	3-801
3.7.17.1 T76511 Temper . . . . .	3-803
3.7.18 7449 ALLOY . . . . .	3-805
3.7.18.0 Comments and Properties. . . . .	3-805
3.7.18.1 T7651 Temper . . . . .	3-812
3.7.18.2 T7951 Temper . . . . .	3-815
3.7.19 7475 ALLOY . . . . .	3-821
3.7.19.0 Comments and Properties. . . . .	3-821
3.7.19.1 T61 and T651 Tempers . . . . .	3-825
3.7.19.2 T7351 Temper . . . . .	3-834
3.7.19.3 T761 and T7651 Tempers . . . . .	3-842
3.8 200.0 SERIES CAST ALLOYS . . . . .	3-869
3.8.1 A201.0 ALLOY . . . . .	3-869
3.8.1.0 Comments and Properties . . . . .	3-869
3.8.1.1 T7 Temper . . . . .	3-872
3.8.2 205/TIB2/3P ALLOY . . . . .	3-879
3.8.2.0 Comments and Properties . . . . .	3-879
3.8.2.1.6 Investment Casting . . . . .	3-881
3.8.2.2.6 Sand Casting . . . . .	3-886
3.9 300.0 SERIES CAST ALLOYS . . . . .	3-891
3.9.1 354.0 ALLOY . . . . .	3-891
3.9.1.0 Comments and Properties . . . . .	3-891
3.9.2 355.0 ALLOY . . . . .	3-893
3.9.2.0 Comments and Properties . . . . .	3-893
3.9.3 C355.0 ALLOY . . . . .	3-896
3.9.3.0 Comments and Properties . . . . .	3-896
3.9.4 356.0 ALLOY . . . . .	3-898
3.9.4.0 Comments and Properties . . . . .	3-898
3.9.5 A356.0 ALLOY . . . . .	3-901

# MMPDS-12 TABLE OF CONTENTS

3.9.5.0 Comments and Properties . . . . .	3-901
3.9.5.1 T6 Temper . . . . .	3-904
3.9.6 A357.0/F357.0 ALLOY . . . . .	3-906
3.9.6.0 Comments and Properties . . . . .	3-906
3.9.6.1 T6 Temper . . . . .	3-909
3.9.7 D357.0/E357.0 ALLOY . . . . .	3-910
3.9.7.0 Comments and Properties . . . . .	3-910
3.9.7.1 T6 Temper . . . . .	3-913
3.9.8 359.0 ALLOY . . . . .	3-916
3.9.8.0 Comments and Properties . . . . .	3-916
3.10 ELEMENT PROPERTIES . . . . .	3-919
3.10.1 BEAMS . . . . .	3-919
3.10.1.1 Simple Beams. . . . .	3-919
3.10.1.1.1 Round Tubes. . . . .	3-919
3.10.1.1.2 Unconventional Cross Section . . . . .	3-921
3.10.1.2 Built-Up Beams . . . . .	3-921
3.10.1.3 Thin-Web Beams. . . . .	3-921
3.10.2 COLUMNS . . . . .	3-922
3.10.2.1 Primary Failure . . . . .	3-922
3.10.2.2 Local Failure . . . . .	3-922
3.10.2.3 Column Properties . . . . .	3-922
3.10.3 TORSION . . . . .	3-924
3.10.3.1 General . . . . .	3-924
3.10.3.2 Torsion Properties . . . . .	3-924
REFERENCES - Chapter 3 . . . . .	3-929
APPENDICES . . . . .	A-1
APPENDIX A - Glossary . . . . .	A-1
A.1 Abbreviations . . . . .	A-1
A.2 Symbols . . . . .	A-6
A.3 Definitions . . . . .	A-6
A.4 Conversion of US Units of Measure Used in MMPDS to SI Units . . . . .	A-17
APPENDIX B - Alloy Index . . . . .	B-1
APPENDIX C - Specification Index . . . . .	C-1
C.1 Cross Reference of Canceled MIL Specifications. . . . .	C-14
APPENDIX D - Testing Standards . . . . .	D-1
APPENDIX E - Subject Index . . . . .	E-1