Metallic Materials Properties Development and Standardization (MMPDS)

MMPDS-06

April 2011

Scientific Source:
Metallic Materials design data acceptable to Government procuring or certification agencies.

A joint effort of government, industrial, educational, and international aerospace organizations.

FOREWORD

The Metallic Materials Properties Development and Standardization (MMPDS) Handbook, is an accepted source for metallic material and fastener system allowables for the Federal Aviation Administration (FAA), all Departments and Agencies of the Department of Defense (DoD), and the National Aeronautics and Space Administration (NASA). Per guidance provided by FAA Advisory Circular (AC) 25.613-1 and FAA policy memorandum PS-AIR100-2006-MMPDS, the A and B values contained in the MMPDS have been determined to satisfy the regulatory requirements defined in Title 14 of the Code of Federal Regulations (CFR) 27.613(d), 29.613(d), 25.613(b) and 23.613(b).

MMPDS-06 is the replacement to MMPDS-05 and prior editions as well as the replacement for all editions of MIL-HDBK-5, Metallic Materials and Elements for Aerospace Vehicle Structures Handbook that was maintained by the U.S. Air Force. The last edition, MIL-HDBK-5J, was classified as noncurrent in the Spring of 2004.

This document contains design information on the strength properties of metallic materials and elements for aircraft and aerospace vehicle structures. All information and data contained in this Handbook has been reviewed and approved in a standardized development process. The development and ongoing maintenance process involves certifying agencies, including the FAA, DoD, and NASA, and major material suppliers and material users worldwide. The data and procedures in this Handbook are continuously reviewed, and if needed, are modified or removed for consistency. With advances in materials and fastener systems, and with the review process of existing information, annual updates of the MMPDS are expected. As such, it is recommended that the latest version of the MMPDS be used.

Beneficial comments (recommendations, additions, deletions) and any pertinent data that may be of use in improving this document should be addressed to Secretariat, MMPDS Coordination Activity (614-424-6496 voice or bcommpds@battelle.org email), Battelle, MMPDS, 505 King Avenue, Columbus, OH 43201. You may also contact the Secretariat through the handbook website, www.mmpds.org

This Handbook has been approved for public release with unlimited distribution.

Preparing activity:
FAA - William J. Hughes Technical Center

EXPLANATION OF NUMERICAL CODE

For chapters containing materials properties, a deci-numeric system is used to identify sections of text, tables, and illustrations. This system is explained in the examples shown below. Variations of this deci-numerical system are also used in Chapters 1, 8, and 9.

Example A 2.4.2.1.1

General material category (in this case, steel) . . . . .

A logical breakdown of the base material by family characteristics (in this case, intermediate alloy steels); or for element properties . . . . .

Particular alloy to which all data are pertinent. If zero, section contains comments on the family characteristics . . . . .

If zero, section contains comments specific to the alloy; if it is an integer, the number identifies a specific temper or condition (heat treatment) . . . . .

Type of graphical data presented on a given figure (see following description) . . . . .

Example B 3.2.3.1.X

Aluminum . . . . .

2000 Series Wrought Alloy . . . . .

2024 Alloy . . . . .

T3, T351, T3510, T3511, T4, and T42 Tempers . . . . .

Specific Property as Follows . . . . .

Tensile properties (ultimate and yield strength) 1
Compressive yield and shear ultimate strengths 2
Bearing properties (ultimate and yield strength) 3
Modulus of elasticity, shear modulus 4
Elongation, total strain at failure, and reduction of area 5
Stress-strain curves, tangent-modulus curves 6
Creep 7
Fatigue 8
Fatigue-Crack Propagation 9
Fracture Toughness 10

REGISTERED TRADEMARKS

Trademark	Registered by	Chemistry	UNS Number
15-5PH®	AK STEEL CORP.	15Cr - 4.6Ni - 0.22Cb - 2.8Cu	J92110
		15Cr - 4.5Ni - 0.30Cb - 3.5Cu	S15500
17-4-PH® [1]	ARMCO INC. CORP.	16Cr - 4.1Ni - 0.28Cb - 3.2Cu	J92200
		16.5Cr - 4.0Ni - 4.0Cu - 0.30Cb	S17400
17-7PH®	ARMCO INC. CORP	17Cr-7.1Ni-1.1Al	J17700
ACRES® sleeves	CLICK BOND, INC.	NA	NA
AerMet® 100	CRS HOLDINGS INC.	3.1Cr-11.5Ni-13.5Co-1.2Mo (0.21 - 0.25C)	K92580
AM-350™	ALLEGHENY LUDLUM CORP.	16.5Cr - 4.5Ni - 2.9Mo - 0.10N	S35000
AM-355™	ALLEGHENY LUDLUM CORP.	15.5Cr - 4.5Ni - 2.0Mo - 0.10N	S35500
Cherry®	TEXTRON FASTENING SYSTEMS, INC.	NA	NA
Cherrybucks®	TEXTRON FASTENING SYSTEMS, INC.	NA	NA
Custom450®	CRS HOLDINGS INC.	15Cr - 6.5Ni - 0.75Mo - 0.30 (Cb + Ta) - 1.5Cu	S45000
Custom455®	CRS HOLDINGS INC.	12Cr-8.5Ni-2.0Cu-1.1Ti	S45500
Custom465®	CRS HOLDINGS INC.	6A1- 6V - 2SN	none
Ferrium® S53®	Ques Tek Innovations LLC	10Cr-5.5Ni-14Co-2Mo-1W (0.19-0.23C)	S10500
Hastelloy® X	HAYNES INTERNATIONAL, INC.	47.5Ni-22Cr-1.5Co-9.0Mo	N06002
Elektron® 21	MAGNESIUM ELEKTRON	EV31A	Similar to M12310
HAYNES®	HAYNES INTERNATIONAL, INC.	NA	NA
230®	HAYNES INTERNATIONAL, INC.	59Ni-22Cr-2Mo-14W-0.35Al	N06230
Hi-Lok®	HI-SHEAR CORP.	NA	NA
Hi-Shear®	HI-SHEAR CORP.	NA	NA
HR-120®	HAYNES INTERNATIONAL, INC.	35Fe - 24Cr - 37Ni - 0.65Cb - 0.2N	N08120
HSL180™	HITACHI METALS AND SUMITOMO PRECISION PRODUCTS	12.5Cr-1.0Ni-15.5Co-2.0Mo	NA
INCONEL®	HUNTINGTON ALLOYS CORP.	NA	NA

[1] Shown in the customary form of 17-4PH in the Handbook.

Trademark	Registered by	Chemistry	UNS Number
MP159®	SPS TECHNOLOGY	19Cr - 36Co - 25Ni - 7.0Mo - 0.50Cb - 2.9Ti - 0.20Al - 9.0Fe	R30159
MP35N®	SPS TECHNOLOGY	20Cr - 35Ni - 35Co - 10Mo	R30035
PH13-8® Mo	ARMCO INC. CORP.	13Cr-8.0Ni-2.2Ni-1.1Al	S13800
PH15-7® Mo	ARMCO INC. CORP.	15Cr - 7.1Ni - 2.5Mo - 1.1A1	S15700
RENE´ ® 41	TELEDYNE INDUSTRIES INC.	54Ni - 19Cr - 11Co - 9.8Mo - 3.2Ti - 1.5Al - 0.006B	N0704
ToughMet® 3	Brush Wellman Inc.	77Cu-15Ni-8Sn	C72900

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CHAPTER 1

GENERAL

1.1 PURPOSE AND USE OF DOCUMENT

1.1.1 INTRODUCTION — Since many aerospace companies manufacture both commercial and military products, the standardization of metallic materials design data which are acceptable to Government procuring or certification agencies is very beneficial to those manufacturers as well as governmental agencies. Although the design requirements for military and commercial products may differ greatly, the required design values for the strength of materials and elements and other needed material characteristics are often identical. Therefore, this publication provides standardized design values and related design information for metallic materials and structural elements used in aerospace structures. The data contained herein, or from approved minutes of the Metallic Materials Properties Development and Standardization (MMPDS) handbook coordination meetings, are acceptable to the Federal Aviation Administration (FAA), the Department of Defense (DoD), and the National Aeronautics and Space Administration (NASA). The minutes are copyright protected and are considered approved 30 days after release of meeting minutes, if no objections or corrections have been received by Battelle, or 30 days after a technical change. Approval by the procuring or certificating agency must be obtained for the use of design values for products not contained herein.

MMPDS-06 was prepared by Battelle under contract with the FAA William J. Hughes Technical Center. It is covered under U.S. Copyright and is the only current form of the MMPDS Handbook. It renders MMPDS-03, and prior published versions of MMPDS and MIL-HDBK-5 obsolete. If computerized third-party MMPDS databases are used, caution should be exercised to ensure that the information in these databases is identical to that contained in the Handbook.

Approved printed and electronic copies of MMPDS-06 are available for purchase through Battelle and its approved licensees. Official copies of MMPDS-06 may also be obtained through participation in the MMPDS Industrial Steering Group (ISG) or Government Steering Group (GSG), whichever is appropriate. The ISG is open to membership by all commercial and education organizations, while the GSG is open to membership by all U.S. and foreign government entities. See www.mmpds.org for further information.

1.1.2 SCOPE OF HANDBOOK — This Handbook is primarily intended to provide a source of design mechanical and physical properties and joint allowables. Material property and joint data obtained from tests by material and fastener producers, government agencies, and members of the airframe industry are submitted to MMPDS for review and analysis. Results of these analyses are submitted to the membership during semiannual coordination meetings for approval and, when approved, published in this Handbook.

This Handbook also contains some useful basic formulas for structural element analysis. These formulas are provided in chapter 1 to illustrate how the material data contained in the Handbook may be used. However, structural design and analysis are beyond the scope of this Handbook. While an attempt is made to assure the accuracy of the formulas and analytical methods contained in chapter 1, there is no attempt in this Handbook to provide currently accepted design or analytical methods.

References for data and various test methods are listed at the end of each chapter. The reference number corresponds to the applicable paragraph of the chapter cited. Such references are intended to provide sources of additional information, but should not necessarily be considered as containing data suitable for design purposes.

Applicable testing standards are identified by number only in the text. Full titles for these standards are listed in Appendix D.

The content of this Handbook is arranged as follows:

Chapter(s)	Subjects
1	Nomenclature, Systems of Units, Formulas, Material Property Definitions, Failure Analysis, Column Analysis, Thin-Walled Sections
2-7	Material Properties
8	Joint Allowables
9	Data Requirements, Statistical Analysis Procedures

1.2 NOMENCLATURE

1.2.1 SYMBOLS AND DEFINITIONS — The various symbols used throughout the Handbook to describe properties of materials, grain directions, test conditions, dimensions, and statistical analysis terminology are included in Appendix A.

1.2.2 INTERNATIONAL SYSTEM OF UNITS — Design properties and joint allowables contained in this Handbook are given in customary units of U.S. measure to ensure compatibility with government and industry material specifications and current aerospace design practice. Appendix A.4 may be used to assist in the conversion of these units to Standard International (SI) units when desired.