

**PRIMER ON
ENGINEERING
STANDARDS
EXPANDED TEXTBOOK
EDITION**

Wiley-ASME Press Series List

Primer on Engineering Standards: Expanded Textbook Edition	Greulich	April 2018
Robust Adaptive Control for Fractional-Order Systems with Disturbance and Saturation	Chen	December 2017
Stress in ASME Pressure Vessels, Boilers, and Nuclear Components	Jawad	October 2017
Robot Manipulator Redundancy Resolution	Zhang	October 2017
Combined Cooling, Heating, and Power Systems: Modeling, Optimization, and Operation	Shi	August 2017
Applications of Mathematical Heat Transfer and Fluid Flow Models in Engineering and Medicine	Dorfman	February 2017
Bioprocessing Piping and Equipment Design: A Companion Guide for the ASME BPE Standard	Huitt	December 2016
Geothermal Heat Pump and Heat Engine Systems: Theory And Practice	Chiasson	September 2016
Nonlinear Regression Modeling for Engineering Applications	Rhinehart	September 2016
Fundamentals of Mechanical Vibrations	Cai	May 2016
Introduction to Dynamics and Control of Mechanical Engineering Systems	To	March 2016

PRIMER ON ENGINEERING STANDARDS

EXPANDED TEXTBOOK EDITION

Owen R. Greulich

Vienna, Virginia, USA

Maan H. Jawad

*Global Engineering & Technology
Camas, Washington, USA*

This Work is a co-publication between ASME Press and John Wiley & Sons, Ltd.

WILEY



© 2018 The American Society of Mechanical Engineers

This Work is a co-publication between ASME Press and John Wiley & Sons Ltd

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, except as permitted by law. Advice on how to obtain permission to reuse material from this title is available at <http://www.wiley.com/go/permissions>.

The right of Owen R. Greulich and Maan H. Jawad to be identified as the authors of this work has been asserted in accordance with law.

Registered Offices

John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA

John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Editorial Office

The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

For details of our global editorial offices, customer services, and more information about Wiley products visit us at www.wiley.com.

Wiley also publishes its books in a variety of electronic formats and by print-on-demand. Some content that appears in standard print versions of this book may not be available in other formats.

Limit of Liability/Disclaimer of Warranty

While the publisher and authors have used their best efforts in preparing this work, they make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives, written sales materials or promotional statements for this work. The fact that an organization, website, or product is referred to in this work as a citation and/or potential source of further information does not mean that the publisher and authors endorse the information or services the organization, website, or product may provide or recommendations it may make. This work is sold with the understanding that the publisher is not engaged in rendering professional services. The advice and strategies contained herein may not be suitable for your situation. You should consult with a specialist where appropriate. Further, readers should be aware that websites listed in this work may have changed or disappeared between when this work was written and when it is read. Neither the publisher nor authors shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

Library of Congress Cataloging-in-Publication Data applied for

ISBN: 9781119466178

Cover Design: Wiley

Cover Image: © Anthony Kyriazis/Gettyimages

Set in 10/12pt and TimesLTStd by Spi Global, Chennai, India

Printed and bound by CPI Group (UK) Ltd, Croydon, CR0 4YY

10 9 8 7 6 5 4 3 2 1

*To those who seek excellence through
their knowledge of standards*

Contents

Preface	xiii
Acknowledgments	xv
1 Introduction	1
1.1 Background	1
1.2 Procedures and Rules	5
1.3 Standards	6
1.3.1 <i>History and Purpose of Standards</i>	6
1.3.2 <i>A Few Examples of Standards throughout the Ages</i>	6
1.3.3 <i>Classification</i>	8
1.3.4 <i>Limited Consensus Standards</i>	9
1.3.5 <i>Voluntary Consensus Standards (VCS)</i>	9
1.3.6 <i>Governmental Standards</i>	10
1.4 Applicability of Standards	11
1.4.1 <i>Permissible Materials of Construction, Performance Criteria, and Material Data</i>	13
1.4.2 <i>Safe Design Rules</i>	13
1.4.3 <i>Construction Details</i>	14
1.4.4 <i>Available Methodologies for Inspection and Testing</i>	14
1.4.5 <i>Safe Operating Parameters</i>	14
1.4.6 <i>Conformity Assessment</i>	14
1.5 Summary	15
2 Role of Governments in Standards	17
2.1 Overview	17
2.2 History	19
2.3 Aspects of Governmental Involvement with Standards	19
2.4 General Policies	20
2.5 National versus State, Provincial, or Local Standards Involvement	20

2.6	The US Government and Standards	21
2.7	US Government OMB Circular A119	21
2.8	National Technology Transfer and Advancement Act	23
2.9	National Science and Technology Council	24
2.10	Other US Government Actions	24
2.11	How the Government Uses Standards	24
2.12	US Government as a Participant in VCS Activities	25
2.13	State and Local Standards Use	26
2.14	Other Countries	26
2.15	Summary	27
2.16	Case Studies	27
3	Voluntary Consensus Standards and Codes	29
3.1	Purpose of Standards	30
3.1.1	<i>Standards for Safety and Reliability</i>	30
3.1.2	<i>Standards to Reduce Cost</i>	32
3.1.3	<i>Standards for Increased Flexibility</i>	33
3.1.4	<i>Standards for Promotion of Business</i>	34
3.1.5	<i>Standards to Help Society to Function</i>	35
3.1.6	<i>Consistency</i>	36
3.2	Voluntary Consensus Standards	36
3.3	American National Standard Institute (ANSI)	36
3.4	Codes	38
3.4.1	<i>National Codes</i>	38
3.4.2	<i>International Codes</i>	38
3.5	Some ANSI Accredited Organizations	38
3.5.1	<i>American Society of Mechanical Engineers (ASME)</i>	39
3.5.2	<i>American Society for Testing and Materials (ASTM)</i>	42
3.5.3	<i>American Petroleum Institute (API)</i>	43
3.5.4	<i>UL (Formerly Underwriters Laboratory)</i>	43
3.5.5	<i>National Board of Boiler and Pressure Vessel Inspectors (NBBI)</i>	43
3.5.6	<i>American Society of Civil Engineers (ASCE)</i>	44
3.5.7	<i>Institute of Electrical and Electronics Engineers (IEEE)</i>	44
4	Limited Consensus Standards	45
4.1	Types of Standards	45
4.2	Proprietary versus Nonproprietary Standards	47
4.2.1	<i>Proprietary Standards</i>	47
4.2.2	<i>Nonproprietary Standards</i>	48
4.3	Governmental and Jurisdictional Limited Consensus Standards	48
4.3.1	<i>NASA</i>	48
4.3.2	<i>Army Corp of Engineers</i>	49

4.3.3	<i>National Institute of Standards and Technology (NIST)</i>	49
4.3.4	<i>National Science Foundation (NSF)</i>	49
4.3.5	<i>US Department of Agriculture (USDA) – Forest Service</i>	49
4.3.6	<i>United States Food and Drug Administration (FDA)</i>	50
4.3.7	<i>Municipalities</i>	50
4.4	Case Studies	50
5	Jurisdictional Standards	51
5.1	Regulations and Jurisdictional Requirements	51
5.2	Jurisdictional Standards Implementation	56
5.3	Incorporation by Reference	56
5.3.1	<i>Access to Reference Standards</i>	57
5.3.2	<i>Updating of Reference Standards</i>	57
5.4	Sample Jurisdictional Standard: The OSHA Regulations	58
5.4.1	<i>OSHA General Duty Clause</i>	60
5.5	Summary	61
6	Standards Development Process	63
6.1	Introduction	64
6.2	Voluntary Consensus Standards (VCS)	64
6.3	Government Nonjurisdictional Standards: DOD, NASA, etc.	65
6.4	Governmental Jurisdictional Standards: DOT, FAA, FCC, OSHA, etc.	66
6.5	Corporate Standards	66
6.5.1	<i>Corporate Public Standards</i>	66
6.5.2	<i>Corporate Proprietary Standards</i>	67
6.6	Limited Consensus Standards	67
6.7	Standards Maintenance	68
6.8	Summary	68
6.9	Case Study	68
7	Types of Standards	69
7.1	Introduction	69
7.2	Performance versus Prescriptive	69
7.2.1	<i>Performance Standards</i>	69
7.2.2	<i>Prescriptive Standards</i>	70
7.2.3	<i>Component Standards</i>	71
7.2.4	<i>Hybrid Standards</i>	71
7.3	Geographical, Political, or Economic Extent	72
7.4	Mandatory or Voluntary	72
7.5	Consensus versus Nonconsensus	73
7.6	Purpose	73
7.7	Subject	73

7.8	Surprise Consequences of a Successful Standard	74
7.9	Summary	76
7.10	Case Study	76
8	Conformity Assessment	77
8.1	Introduction	77
8.2	Users of Conformity Assessment	78
	8.2.1 <i>Producers and Manufacturers</i>	79
	8.2.2 <i>Users and their Designated Agents</i>	79
	8.2.3 <i>Inspection/Insurance Agencies and Inspection Jurisdictions</i>	79
	8.2.4 <i>Governmental Agencies</i>	80
8.3	Applicability of Conformity Assessment	80
	8.3.1 <i>Employees</i>	80
	8.3.2 <i>Processes</i>	81
	8.3.3 <i>Products</i>	81
	8.3.4 <i>Services</i>	81
	8.3.5 <i>Systems</i>	82
8.4	Verification and Validation Process	82
8.5	Conformity Assessment Organizations	84
8.6	Summary	85
8.7	Case Studies	85
9	Standards Interpretation and Relief	87
9.1	General Discussion	87
9.2	Standards Adoption	88
9.3	Effect of Noncompliance with Standards	89
	9.3.1 <i>New Products</i>	90
	9.3.2 <i>Post-Manufacturing Noncompliance</i>	92
9.4	Standards Interpretation	95
	9.4.1 <i>Informal Processes</i>	95
	9.4.2 <i>Formal Interpretations</i>	95
9.5	Tailoring	97
	9.5.1 <i>Nonmandatory Standards Tailoring</i>	98
	9.5.2 <i>Legislative Tailoring</i>	98
	9.5.3 <i>Governmental Agency Supplemental Standards</i>	98
9.6	Waivers and Variances	99
	9.6.1 <i>Waivers of Corporate Standards</i>	99
	9.6.2 <i>Code Cases</i>	100
	9.6.3 <i>Variances from Jurisdictional Standards</i>	101
9.7	Summary	103
9.8	Case Study	103

10	Characteristics of a Good Standard	105
10.1	Introduction	105
10.2	Clarity and Understanding	105
10.3	Scope	106
10.4	Terminology	107
10.5	Structure and Organization	107
10.6	Consistency	109
10.7	References to Other Standards	109
10.8	Attention to Details	109
10.9	Supplementing a Standard	110
10.10	Timeliness	110
10.11	Sample Standard Structure	110
10.12	Summary	112
10.13	Case Studies	112
11	Getting Involved in Standards Development	113
11.1	Introduction	113
11.2	Reasons to Get Involved	113
	<i>11.2.1 Influence the Process and the Product</i>	113
	<i>11.2.2 Opportunity to Learn</i>	114
	<i>11.2.3 Credibility</i>	114
	<i>11.2.4 Personal Satisfaction</i>	115
	<i>11.2.5 Networking and Career Benefits</i>	115
11.3	Opportunities for Involvement in Standards	116
	<i>11.3.1 Company Standards</i>	116
	<i>11.3.2 Interest Group Standards</i>	116
	<i>11.3.3 Voluntary Consensus Standards (VCS)</i>	116
	<i>11.3.4 Jurisdictional Standards</i>	117
11.4	Selecting a Committee	117
	<i>11.4.1 Finding a Committee</i>	117
	<i>11.4.2 Making the Choice</i>	118
11.5	What Does It Require?	118
11.6	Summary	119
	Acronyms	121
Appendix A	Deciding Not to Use a Standard	125
A.1	Introduction	125
A.2	Reasons Not to Use a Standard	126
	<i>A.2.1 Lack of a Standard</i>	126
	<i>A.2.2 Overly Constraining</i>	126
	<i>A.2.3 Unique Product or Application</i>	126
	<i>A.2.4 Basic Services</i>	127

A.2.5	<i>Patented Products</i>	127
A.3	Consequences of Not Using a Standard	127
A.4	Mitigations for Not Using a Standard	128
A.5	Summary	129
Appendix B Some SDOs developing Voluntary Consensus Standards		131
Appendix C Some Industrial Organizations That Publish Limited Consensus Standards		135
Appendix D Some US Government Jurisdictional Agencies		137
Bibliography		139
Biography		141
Index		143

Preface

Engineering principles including classical and numerical analysis as well as other engineering techniques are essential for the engineer to perform various designs. However, as society gets more interdependent and the common implements of daily life more complex and sophisticated, standards become more and more indispensable as additional engineering tools. This book introduces the concept of standards as well as their impact and value. It includes a brief history of standards and it addresses the different ways in which they come about. Some of the chapters discuss the role of government in creating standards as well as the processes by which nongovernmental standards are produced. Other chapters discuss the different types and applications of standards, how interpretations of standards are obtained, the problem of how to ensure conformity with standards, and what might be done when conformity cannot be attained.

Some characteristics of a “good standard” are presented, along with some pitfalls to avoid in producing a standard. Benefits of getting involved in the standards development process are explained, along with pointers on both selecting a standards organization to get involved with and how to go about it. This book provides a short synopsis of “Standards” to enable the reader get a quick understanding of the various aspects, ramifications, and implications of standards. It consists of eleven chapters and four appendices. Various case studies are included to help the reader develop an in-depth understanding of the topics discussed. The wide range of topics covered in this book is intended to give the reader a good starting point in understanding how standards play an integral part of the engineering profession.

There are tens, perhaps hundreds of thousands of engineering standards worldwide, covering every imaginable subject related to engineering. Listing them all

would be a monumental undertaking and this book, by necessity, covers only a small portion of them. The appendices at the end of this book provide assistance in identifying a few of these engineering standards, who developed and maintains them, and contact information to help the reader obtain further information.

April, 2018

Owen R. Greulich
Washington, DC

Maan H. Jawad
Camas, Washington

Acknowledgments

The authors acknowledge Mark Jawad for providing background information on the USB standard and Kevin Jawad for providing history regarding computer development.

We also acknowledge Cathy Greulich and Dixie Jawad for their patience while the authors were writing the manuscript, and special thanks are extended to Mary Grace Stefanchik and to all the other ASME and Wiley personnel for their valuable assistance and guidance on the book.

