

ASME Y14.41-2019
(Revision of ASME Y14.41-2012)

Digital Product Definition Data Practices

**Engineering Product Definition and
Related Documentation Practices**

AN INTERNATIONAL STANDARD



**The American Society of
Mechanical Engineers**

ASME Y14.41

ADOPTION NOTICE

ASME Y14.41, Digital Product Definition Data Practices, was adopted on 7 July 2003 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: Commander, U.S. Army (ARDEC), ATTN: RDAR-QES-E, Picatinny Arsenal, NJ 07806-5000. Copies of this document may be purchased from The American Society of Mechanical Engineers (ASME), 150 Clove Road, 6th Floor, Little Falls, NJ 07424-2139; <http://www.asme.org>.

Custodians:

Army — AR
Navy — SA
Air Force — 16

Adopting Activity:

Army — AR
(Project DRPR-2011-001)

Review Activities:

Army — CR, MI, PT, TE, TM
Navy — AS, CG, CH, EC, MC, NP, TD
Air Force — 13, 99
OSD — SE
NGA — MP
NSA — NS
Civil agency:
DLA — DH, IS

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://quicksearch.dla.mil>.

ASMC N\A

FSC DRPR

DISTRIBUTION STATEMENT A. Approved for public release, distribution is unlimited.

ASME Y14.41-2019
(Revision of ASME Y14.41-2012)

Digital Product Definition Data Practices

**Engineering Product Definition and
Related Documentation Practices**

AN INTERNATIONAL STANDARD



**The American Society of
Mechanical Engineers**

Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: September 6, 2019

The next edition of this Standard is scheduled for publication in 2024.

Periodically certain actions of the ASME Y14 Committee may be published as Cases. Cases are published on the ASME website under the Y14 Committee Page at <http://go.asme.org/Y14committee> as they are issued.

Errata to codes and standards may be posted on the ASME website under the Committee Pages to provide corrections to incorrectly published items, or to correct typographical or grammatical errors in codes and standards. Such errata shall be used on the date posted.

The Y14 Committee Page can be found at <http://go.asme.org/Y14committee>. There is an option available to automatically receive an e-mail notification when errata are posted to a particular code or standard. This option can be found on the appropriate Committee Page after selecting "Errata" in the "Publication Information" section.

ASME is the registered trademark of The American Society of Mechanical Engineers.

This international code or standard was developed under procedures accredited as meeting the criteria for American National Standards and it is an American National Standard. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed code or standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

ASME does not "approve," "rate," or "endorse" any item, construction, proprietary device, or activity.

ASME does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable letters patent, nor assume any such liability. Users of a code or standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this code or standard.

ASME accepts responsibility for only those interpretations of this document issued in accordance with the established ASME procedures and policies, which precludes the issuance of interpretations by individuals.

No part of this document may be reproduced in any form,
in an electronic retrieval system or otherwise,
without the prior written permission of the publisher.

The American Society of Mechanical Engineers
Two Park Avenue, New York, NY 10016-5990

Copyright © 2019 by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
All rights reserved
Printed in U.S.A.

CONTENTS

Foreword	vii	
Committee Roster	viii	
Correspondence With the Y14 Committee	ix	
Section 1	General	1
1.1	Scope	1
1.2	Structure of Standard	1
1.3	ASME Y14 Series Conventions	1
1.4	Reference to This Standard	2
1.5	Symbols	2
Section 2	References	3
2.1	Introduction	3
2.2	Cited Standards	3
Section 3	Terms and Definitions	4
Section 4	Data Set Identification and Control	7
4.1	General	7
4.2	Related Data	7
4.3	Data Management	7
Section 5	Data Set Requirements	9
5.1	General Annotated Model Requirements	9
5.2	General Method Requirements	11
5.3	Management Data	11
5.4	Security Markings	12
5.5	Views on Annotated Models	12
Section 6	Model Requirements	13
6.1	General	13
Section 7	Annotated Model and Drawing Graphic Sheet Requirements	14
7.1	Common Requirements	14
7.2	Annotated Model Requirements	14
7.3	Drawing Graphic Sheet Requirements	16
Section 8	Notes and Special Notations	31
8.1	Common Requirements	31
8.2	Annotated Model Requirements	31
8.3	Drawing Graphic Sheet Requirements	31
Section 9	Model Values and Dimensions	32
9.1	Common Requirements	32
9.2	Annotated Model Requirements	32
9.3	Drawing Graphic Sheet Requirements	33
Section 10	Plus and Minus Tolerances	37

10.1	Common Requirements	37
10.2	Annotated Model Requirements	37
10.3	Drawing Graphic Sheet Requirements	37
Section 11	Datum Applications	44
11.1	Common Requirements	44
11.2	Annotated Model Requirements	44
11.3	Drawing Graphic Sheet Requirements	45
Section 12	Geometric Tolerances	60
12.1	Common Requirements	60
12.2	Annotated Model Requirements	60
12.3	Drawing Graphic Sheet Requirements	61
Section 13	Welds	102
13.1	Common Requirements	102
13.2	Annotated Model Requirements	102
13.3	Drawing Graphic Sheet Requirements	104
Section 14	Surface Texture	105
14.1	Common Requirements	105
14.2	Annotated Model Requirements	105
14.3	Drawing Graphic Sheet Requirements	106

Nonmandatory Appendices

A	Compliance Responsibility	110
B	Classification Codes for Drawings and Data Sets	115

Figures

4-1	Contents of a Product Definition Data Set	8
5-1	Left-Hand and Right-Hand Coordinate Systems	10
7-1	Display Management	17
7-2	Annotation and Model Geometry Relationship	19
7-3	Tolerance Query Associativity	20
7-4	Simplified Feature Representation and Attributes	22
7-5	Annotation Planes Relative to Annotated Model Geometry	23
7-6	Graphic Display of Associated Annotation	24
7-7	Listing of Digital Element Identifiers	25
7-8	Queries for Datum Feature Symbols and Datum Target Symbols	25
7-9	Queries for Datum Targets	26
7-10	Queries for Coordinates and Supplemental Geometry	27
7-11	Annotated Model	28
7-12	Model and Drawing Graphic Sheet	29
7-13	Query for Nonuniform Tolerance Zones	30
9-1	Placement and Attachment of Basic Dimensions	34
9-2	Placement and Attachment of Size Dimensions	35
10-1	Attachment Techniques: Fillets, Rounds, and Chamfers	39
10-2	Attachment Techniques: Reliefs and Step Surfaces	40
10-3	Attachment Techniques: Countersinks and Oblique Surfaces	41

10-4	Attachment Techniques: Depth, Spotface, Remaining Thickness	42
10-5	Attachment Techniques: Notches, Flats, and Pin Heights	43
11-1	Datum System and Coordinates Relationship	47
11-2	Datum Feature Symbol Attachments	49
11-3	Partial Surface as a Datum Feature	50
11-4	Datum Targets and Symbols Attachment	51
11-5	Equalizing Target Points Establish a Datum Axis on an Internal Cylindrical Surface	52
11-6	Two Cylindrical Features Establish a Datum Axis	53
11-7	Pattern of Features Establish a Datum Axis	54
11-8	Two Coaxial Features Establish a Datum Axis	55
11-9	Coplanar Surfaces Establish a Datum Plane	56
11-10	Separated Surfaces Establish a Datum Plane	57
11-11	Datum Targets and Symbols in an Axonometric View	59
12-1	General Application of Geometric Tolerances — Coincident or Perpendicular Annotation Plane	63
12-2	Circularity — Sphere, Conical, or Revolved Surface	65
12-3	Cylindricity	66
12-4	Straightness — Directed by Line Element	67
12-5	Straightness — Directed by Ordinate Axis	68
12-6	Straightness — Cylindrical or Conical Surface	69
12-7	Straightness — Median Line and Flatness: Median Plane	69
12-8	Orientation — Planar Surfaces	71
12-9	Each Element Orientation — Directed by Line Element	72
12-10	Each Element Orientation — Directed by Ordinate Axis	73
12-11	Orientation — Inclined Surface	74
12-12	Orientation — Cylinder or a Set of Opposed, Parallel Surfaces	75
12-13	Orientation of an Axis With a Parallel Planes Tolerance Zone	76
12-14	Profile — Planar, Conical, or Revolved Surface	78
12-15	Profile — Multiple or Coplanar Surfaces	79
12-16	Profile — Between Basis	80
12-17	Profile — All-Around Applications	81
12-18	Line Profile — Directed by Line Element	82
12-19	Line Profile — Directed by Ordinate Axis	83
12-20	Nonuniform Profile Tolerance Zones — Use of Supplemental Geometry	85
12-21	Position — Individual Patterns of Features	86
12-22	Position — Projected Tolerance Zones	87
12-23	Position — Extremities of Long Holes	88
12-24	Position — Elongated Holes (Slots)	89
12-25	Bidirectional Position — Polar or Rectangular	90
12-26	Position — Combined With Profile	91
12-27	Runout — Attachments and Associativity	93
12-28	Runout — Perpendicular and Cylindrical Surfaces	94
12-29	Runout — Spherical, Conical, and Revolved Surfaces	95
12-30	Axonometric Views — Feature Control Frames	96
12-31	Axonometric Views — Limited Area Application	97
12-32	Axonometric Views — Straightness, Each Element Applications	98

12-33	Axonometric Views — Parallel Planes Tolerance Zone	99
12-34	Axonometric Views — Multiple Surfaces	100
12-35	Axonometric Views — Between Basis	101
13-1	Placement of a Welding Symbol	102
13-2	Extent of a Weld Using the Between Symbol	103
13-3	Indication of Location of Fillet Welds	103
13-4	Indication of Location of Spot Welds	104
13-5	Query of a Weld Path	104
14-1	Surface Texture Attached With a Leader to a Surface	105
14-2	Surface Texture Attached to a Feature Control Frame	106
14-3	Surface Texture Attached to a Dimension for a Feature of Size	107
14-4	Surface Texture Attached to a Dimension for a Width	108
14-5	Direction of Lay by Ordinate Axes	108
14-6	Direction of Lay With Supplemental Geometry	109
 Tables		
9-1	Resolved Dimension Examples	36
10-1	Plus and Minus Tolerance Applications	38
12-1	Form Tolerances	64
12-2	Orientation Tolerances	70
12-3	Profile Tolerances	77
12-4	Location Tolerances	84
12-5	Runout Tolerances	92
A-1	Compliance Responsibility	111

FOREWORD

The development of this Standard was initiated at the request of industry and the government. A meeting was held to determine the interest in this subject in January 1997 in Wichita, Kansas, hosted by The Boeing Company in their facility. A subsequent meeting was held during the spring ASME meeting in 1997 to enlist membership of those who would be interested in working on this project.

The Chairs of the different Y14 standards continue to collaborate to improve the coordination of the Y14 standards. To this end, in this revision of ASME Y14.41 material regarding surface finish and weld symbols applied to the model has been added. The definitions for classification codes for data sets were developed within Y14.41 to describe the combinations of annotated model and drawing graphic sheets that might be required by a customer. These were given to ASME Y14.100-2013 and placed in Nonmandatory Appendix F. Seeing that most of these classification codes contain a model/annotated model, Nonmandatory Appendix F was duplicated and placed here as [Nonmandatory Appendix B](#). At a later date, the classification codes that appear in ASME Y14.100-2017, Appendix F, will be removed and reference to Y14.41.

A clarification of the terms “model” and “annotated model” was added. An example of a nonuniform tolerance zone is shown and explained. This revision also provides guidance to limit the use of applying GD&T through notes suggesting that the use of annotation will allow for automated tools to consume those design requirements. [Nonmandatory Appendix A, Table A-1](#) was added which contains information whether the requirements defined in this Standard can be accomplished completely by the data preparer or capabilities need to be provided by the software to meet the requirements. These additions allow the reader to find all of the requirements and information within the Standard.

It is essential that this Standard be used in close conjunction with ASME Y14.24, ASME Y14.34, ASME Y14.35, and ASME Y14.100. Although the primary purpose of ASME Y14 series standards is to establish requirements for the preparation and revision of product definition data, this Standard also includes various software-dependent requirements that may not be achievable without computer software tools that have been developed in support of facilitating these requirements. Examples of such requirements include associativity, stationary and rotating annotation planes, display management, attributes available on demand, annotation and annotation plane orientation, query, highlighting, and resolved dimension preservation and association. See [Nonmandatory Appendix A](#) for details.

This Standard is available for public review on a continuing basis. This provides an opportunity for additional public review input from industry, academia, regulatory agencies, and the public-at-large.

This edition was approved as an American National Standard on March 22, 2019.

ASME Y14 COMMITTEE

Engineering Product Definition and Related Documentation Practices

(The following is the roster of the Committee at the time of approval of this Standard.)

STANDARDS COMMITTEE OFFICERS

W. A. Kaba, *Chair*
J. I. Miles, *Vice Chair*
F. Constantino, *Secretary*

STANDARDS COMMITTEE PERSONNEL

A. R. Anderson , Spirit AeroSystems, Inc.	E. F. McCarthy , Raytheon Missile Systems
F. Bakos, Jr. , Consultant	P. J. McCuiston , Multimac
J. V. Burleigh , Unaffiliated	J. D. Meadows , James D. Meadows & Associates, Inc.
F. Constantino , The American Society of Mechanical Engineers	M. E. Meloro , Northrop Grumman Corp.
R. M. Courson , SAE International	J. I. Miles , Technical Consultants, Inc.
D. E. Day , Tec-Ease, Inc.	M. A. Murphy , General Motors Co.
K. Dobert , Siemens PLM Software	H. W. Oakes , USAF (SAIC)
D. H. Honsinger , Consultant	M. J. Stahl , Caterpillar, Inc.
J. B. Hoskins , The Boeing Co.	B. A. Wilson , Consultant
R. C. Jensen , Hexagon Manufacturing Intelligence	E. Zwettler , Rolls-Royce Corp.
W. A. Kaba , Spirit AeroSystems, Inc.	K. E. Wiegandt , <i>Contributing Member</i> , Consultant
A. Krulikowski , Effective Training, Inc.	

SUBCOMMITTEE 41 — DIGITAL PROJECT DEFINITION DATA PRACTICES

J. I. Miles , <i>Chair</i> , Technical Consultants, Inc.	G. R. Mussell , CNH America, LLC
J. B. Hoskins , <i>Vice Chair</i> , The Boeing Co.	R. Nascimento , ITI — International Techgroup
J. V. Burleigh , Unaffiliated	D. Newman , Rockwell Collins
W. S. Cockrell , Raytheon Missile Systems	H. W. Oakes , USAF (SAIC)
B. A. Davis , Ford Motor Co.	T. T. Taylor , Siemens Energy, Inc.
G. T. Follett , Raytheon Co.	M. D. Toye , GE Aviation
K. Fry , Lockheed Martin Space	J. C. Weers , Unaffiliated
A. S. Hall , Rolls-Royce Corp.	N. J. Weister , Eaton Corp.
S. Hauger , John Deere	R. A. Wheeler , RW-Opt Design, LLC
T. D. Hedberg , NIST	R. D. Whittenburg , MBD 360, LLC
L. R. Maggiano , Mitutoyo America Corp.	A. Wight , The Boeing Co.
T. J. Miler , Ford Motor Co.	

Y14/SC 41 SUPPORT GROUP

N. Bonhomme , Videotron	R. C. Hearn , The Boeing Co.
N. Crawford , Crawford Dimensional Management	P. J. Huang , Navy Mantech
B. R. Fischer , Advanced Dimensional Management, LLC	H. D. Taylor , GE Aviation
S. W. Graham , General Electric	J. Van Horn , The Boeing Co.

CORRESPONDENCE WITH THE Y14 COMMITTEE

General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions or a case, and attending Committee meetings. Correspondence should be addressed to:

Secretary, Y14 Standards Committee
The American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
<http://go.asme.org/Inquiry>

Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Proposing a Case. Cases may be issued to provide alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee web page.

Requests for Cases shall provide a Statement of Need and Background Information. The request should identify the Standard and the paragraph, figure, or table number(s), and be written as a Question and Reply in the same format as existing Cases. Requests for Cases should also indicate the applicable edition(s) of the Standard to which the proposed Case applies.

Attending Committee Meetings. The Y14 Standards Committee regularly holds meetings and/or telephone conferences that are open to the public. Persons wishing to attend any meeting and/or telephone conference should contact the Secretary of the Y14 Standards Committee. Future Committee meeting dates and locations can be found on the Committee Page at <http://go.asme.org/Y14committee>.

INTENTIONALLY LEFT BLANK

Section 1

General

1.1 SCOPE

This Standard establishes requirements and references documents applicable to the preparation and revision of digital product definition data, hereafter referred to as data sets. This Standard defines exceptions and additional requirements to existing ASME standards for using digital product definition data set(s) or drawing graphic sheet(s) in digital format, hereafter referred to as drawing graphic sheet(s). When no exception or additional requirements are stated, existing ASME standards shall apply. It is essential that this Standard be used in close conjunction with ASME Y14.24, ASME Y14.34, ASME Y14.35, and ASME Y14.100.

1.2 STRUCTURE OF STANDARD

This Standard supports two methods of preparing a data set: annotated model, and an annotated model with a drawing graphic sheet. See [paras. 5.2.1](#) and [5.2.2](#). The structure starts with the requirements common to both methods, and then branches to the other sections that have differing requirements for each method. In addition, it provides a guide for the many Computer-Aided Design (CAD) software packages to develop better modeling and annotation practices for CAD and engineering disciplines.

1.3 ASME Y14 SERIES CONVENTIONS

The conventions in [paras. 1.3.1](#) through [1.3.9](#) are used in this and other ASME Y14 standards.

1.3.1 Mandatory, Recommended, Guidance, and Optional Words

- (a) The word "shall" establishes a requirement.
- (b) The word "will" establishes a declaration of purpose on the part of the design activity.
- (c) The word "should" establishes a recommended practice.
- (d) The word "may" establishes an allowed practice.
- (e) The words "typical," "example," "for reference," or the Latin abbreviation "e.g." indicate suggestions given for guidance only.

(f) The word "or" used in conjunction with a requirement or a recommended practice indicates that there are two or more options for complying with the stated requirement or practice.

(g) The phrase "unless otherwise specified" or UOS shall be used to indicate a default requirement. The phrase is used when the default is a generally applied requirement and an exception may be provided by another document or requirement.

1.3.2 Cross-Reference of Standards

Cross-reference of standards in text with or without a date following the standard designator shall be interpreted as follows:

(a) Reference to other ASME Y14 standards in the text without a date following the standard designator indicates that the issue of the standard identified in the References section ([Section 2](#)) shall be used to meet the requirement.

(b) Reference to other ASME Y14 standards in the text with a date following the standard designator indicates that only that issue of the standard shall be used to meet the requirement.

1.3.3 Invocation of Referenced Standards

The following examples define the invocation of a standard when specified in the References section ([Section 2](#)) and referenced in the text of this Standard:

(a) When a referenced standard is cited in the text with no limitations to a specific subject or paragraph(s) of the standard, the entire standard is invoked. For example, "Dimensioning and tolerancing shall be in accordance with ASME Y14.5" is invoking the complete standard because the subject of the standard is dimensioning and tolerancing and no specific subject or paragraph(s) within the standard are invoked.

(b) When a referenced standard is cited in the text with limitations to a specific subject or paragraph(s) of the standard, only the paragraph(s) on that subject is invoked. For example, "Assign part or identifying numbers in accordance with ASME Y14.100" is invoking only the paragraph(s) on part or identifying numbers because the subject of the standard is engineering drawing practices and part or identifying numbers is a specific subject within the standard.