



National Aeronautics and
Space Administration

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NASA-STD-2817
SEPTEMBER 15, 1998

COMPUTER-AIDED ENGINEERING, DESIGN AND MANUFACTURING DATA INTERCHANGE STANDARDS

NASA TECHNICAL STANDARD

FOREWORD

This standard is approved for use by NASA Headquarters and all NASA Centers and is intended to provide a common framework for consistent practices across NASA programs.

The material covered in this standard is based on the consensus judgment of the NASA Chief Information Officer (CIO) Representatives Board and the NASA CIO Council. The purpose of this standard is to establish the minimum tool suite for data interchange standards to support interoperability among the engineering design and manufacturing communities of NASA.

Requests for information, corrections, or additions to this standard should be directed to Lewis Research Center (LeRC), the Principal Center for Workgroup Hardware and Software, Code 7100, MS 142-2, Cleveland, OH, 44135. Requests for additional copies of this standard should be sent to NASA Engineering Standards, EL01, MSFC, AL, 35812 (telephone 256-544-2448). This and other NASA standards may be viewed and downloaded, free-of-charge, from our NASA Standards Homepage: <http://standards.nasa.gov>.

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Chief Information Officer

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CONTENTS

<u>PARAGRAPH</u>		<u>PAGE</u>
	<u>FOREWORD</u>	i
	<u>CONTENTS</u>	iii
1.	<u>SCOPE</u>	1
1.1	Purpose.....	1
1.2	Scope.....	1
1.3	Applicability	1
2.	<u>ACRONYMS AND DEFINITIONS</u>	1
3.	<u>REQUIREMENTS</u>	2
3.1	General Requirements	2
3.2	Specific Requirements	3
3.2.1	Product Data Management Systems.....	3
3.2.2	Mechanical CAD/CAM Systems	3
3.2.3	Electronic CAD/CAM Systems	4
3.2.4	Civil and Facilities CAD Systems	4
3.2.5	Computer-Aided Engineering Analysis.....	4
3.2.6	Other Systems	4
4.	<u>DURATION</u>	4

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COMPUTER-AIDED ENGINEERING, DESIGN, AND MANUFACTURING (CAE/CAD/CAM) DATA INTERCHANGE STANDARDS

1. SCOPE

1.1 Purpose. One of the challenges facing NASA is the need to execute engineering projects across the Agency using multiple discipline work groups in a collaborative environment. Not only are there organizational issues such as scheduling and availability of talent, but also there are significant technical issues with sharing data between dissimilar hardware and software products. Therefore, there is a requirement for NASA to define common tools and data interchange standards that will enable engineering projects to interchange and integrate engineering, design, and manufacturing data.

The purpose of this standard is to establish the minimum interoperability standards for the minimum tool suite that every CAE/CAD/CAM installation at NASA must have. These standards will allow a smooth exchange of CAE/CAD/CAM data between work groups for current and future joint development projects.

1.2 Scope. This document establishes the minimum interoperability standards that each CAE/CAD/CAM system at NASA must support to allow data to be interchanged between it and other systems. CAE/CAD/CAM implementations must also be consistent with the overall NASA IT architecture and standards.

Application of this standard to a particular application does not assume the need for 100% file exchange. Some human dialog should be sufficient to ensure the exchange meets the needs of both sender and receiver.

1.3 Applicability. The standard applies to all interoperable CAE/CAD/CAM installations at all NASA Centers. Deviations from this standard will follow the waiver process defined in NASA Policy Directive (NPD) 2800.1, *Managing Information Technology*, and in NASA Procedures and Guidelines (NPG) 2800.1, *Managing Information Technology*.

2. ACRONYMS AND DEFINITIONS

AP	Application Protocol, used within the STEP standards
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CAD	Computer-Aided Design, used here to include all disciplines, including architectural, civil, electronic, electrical, mechanical, and piping systems
CAE	Computer-Aided Engineering
CAM	Computer-Aided Manufacturing
CD	Committee Draft
CIO	Chief Information Officer
COTS	Commercial Off-The-Shelf
DIS	Draft International Standard
DXF	Drawing Interchange Format
EDIF	Electronic Design Interchange Format
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers

IGES	Initial Graphics Exchange Specification
ISO	International Standards Organization
IT	Information Technology
NASA	National Aeronautics and Space Administration
NPD	NASA Policy Directive
NPG	NASA Procedures and Guidelines
PCA	Printed Circuit Assembly
PCB	Printed Circuit Board
PDM	Product Data Management
STEP	STandard for the Exchange of Product model data
VHDL	VHSIC Hardware Description Language
VHSIC	Very High Speed Integrated Circuit

3. REQUIREMENTS

3.1 General Requirements. In the past, engineers would create separate models for each discipline to use in their analysis, simulation, design, fabrication, procurement, or inspection processes. While the models met the needs of that independent work effort, it was common to experience difficulties in interpreting exchanged data when collaborative work was involved. This complicated re-works and produced delays in handling revisions as the project developed. With today's CAE/CAD/CAM systems and interchange tools, much of the model construction and its re-work can be eliminated, and the delays greatly reduced by model sharing based on compatible interchange standards.

By using neutral data interchange standards, based on industry consensus, meaningful data can be extracted from CAE/CAD/CAM models and quickly transferred to other systems with different implementations of the same standards for immediate use by those specialists. Since many different views of the same fundamental data items are both possible and necessary, the suite of standards chosen must be robust, flexible, and complete to meet these varying users' needs.

For example, an assembly of several printed circuit boards in a card cage requires passing the physical data about each board from the electronic CAD system to the mechanical CAD system. Such an interchange would not require circuit information. If the interchange was to a thermal analysis system, some simplified geometry information would be needed along with the thermal characteristics of each component. If the interchange was to a parts ordering system, the bills of material data would be needed, including vendor identifications where known. In this instance, interchange would not require geometric information to be passed.

Because these interchange tools will allow data to flow among multiple design or analysis tools, the standards must also include Product Data Management (PDM) capabilities to allow revision control issues to be addressed each time to ensure data integrity.

Finally, NASA recognizes the requirement to interchange data with its industrial and academic partners. For that reason NASA is an active participant in industry/Government consortia activities working to accelerate the development and implementation of national and international standards for product data representation, exchange, and management.

The primary standards identified below have been widely accepted by these consortia. It is the intent of NASA to adhere to standards promulgated by these consortia to the maximum extent possible.

3.2 Specific Requirements. This section lists the interchange standards with which all CAE/CAD/CAM systems in NASA must be generally compliant. Tools that enable data interchange, compliant with these standards, must be available to all CAE/CAD/CAM users at each Center. It is not required that every CAE/CAD/CAM system installation implement every data interchange module, but a workable agreement must be in place for any user to access the appropriate tools and trained staff within their Center.

The revision of each cited standard is as of the date of this publication. It is the intent of NASA to move forward as STEP standards are modified and compliant COTS products become available. NASA will choose if or when to incorporate new products or versions of STEP into the NASA standards suite based upon evaluation of how well the standards and products meet NASA requirements. NASA will accept the results of the National Institutes of Standards and Technology (NIST) compliance testing process as evidence of vendor product compliance (see <http://www.nist.gov/sc4>, or contact Simon P. Frechette, NIST, 301-975-3335).

3.2.1 Product Data Management Systems. For Product Data Management (PDM) systems that will store and control all data, in any format, related to a design project, the interchange tools must support the following standard:

STEP ISO 10303-203, 1994, Industrial Automation Systems and Integration – Product data representation and exchange - Part 203: Application Protocol: Configuration Controlled Design, First Edition. Subtitled: Configuration controlled 3D design of mechanical parts and assemblies

3.2.2 Mechanical CAD/CAM Systems. For mechanical CAD/CAM systems, interchange tools that support the following STEP standard are required. Note, IGES may still be used as a recognized, interim tool and is allowed according to the waiver procedure in Section 1.3:

STEP ISO 10303-203, 1994, Industrial Automation Systems and Integration - Product data representation and exchange - Part 203: Application Protocol: Configuration Controlled Design, First Edition. Subtitled: Configuration controlled 3D design of mechanical parts and assemblies.

IGES ANSI/ASME Y14.26M-1989, Digital Representation for Communication of Product Definition Data. This is Revision 4.0.0.

3.2.3 Electronic CAD/CAM Systems. For electronic CAD/CAM systems, interchange tools that support the following STEP standard are required. Note: EDIF may still be used as a recognized, interim tool and is allowed according to the waiver procedure in Section 1.3. Where electronic design and analysis processes require a Hardware Description Language, either VHDL or Verilog may be used.

- STEP ISO/DIS 10303-210, Industrial Automation Systems and Integration – Electronic assembly, interconnect, and packaging design - Part 210. As of this publication date, this standard is in its final review stages. (Note: AP 210 is a Draft International Standard [DIS] whose technical content is baselined.)
- EDIF IEC 61691-1, 1997, Design Automation - Part 1: VHDL Language Reference Manual, First Edition.
- VHDL ANSI/IEEE 1076, 1993, Standard VHDL Language Reference Manual.

3.2.4 Civil and Facilities CAD Systems. For civil engineering and facility design CAD systems, interchange tools that support one of the following standards are required. (Note: APs 225 and 227 are Draft International Standards [DIS] whose technical content is baselined.)

- STEP ISO/DIS 10303-225, Industrial Automation Systems and Integration - Product data representation and exchange - Part 225. Subtitled: Building Elements Using Explicit Shape Representation.
- STEP ISO/DIS 10303-227, Industrial Automation Systems and Integration - Product data representation and exchange - Part 227. Subtitled: Plant Spatial Configuration.
- DXF AutoCAD Customization Guide, Appendices B and C, version number u14.1.03, Autodesk, Inc.

3.2.5 Computer-Aided Engineering/Analysis. For engineering analysis, interchange tools that support the following standard are required:

- STEP ISO/CD 10303-209, Industrial Automation Systems and Integration - Product data representation and exchange - Part 209. Subtitled: Composite and metallic structural analysis and related design. As of this publication date, this standard is in its final editing stages before issuance as a Draft International Standard (DIS).

3.2.6 Other Systems. Interchange tools for other CAE/CAD/CAM disciplines will be added to this standard as they are implemented. Parts of STEP in development for piping, cabling, and composites will be incorporated when they become available. Similarly, the STEP AP for manufacturing will be adopted when it becomes available.

4. DURATION

This standard will remain in effect until it is canceled or modified by the NASA CIO.