DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
2531 JEFFERSON DAVIS HWY
ARLINGTON VA 22242-5160

IN REPLY REFER TO

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NAVSEA INSTRUCTION 9040.3

From: Commander, Naval Sea Systems Command

Subj: DEVELOPMENT, MAINTENANCE, AND EXCHANGE OF PRODUCT MODEL DATA BY SHIP AND SYSTEM PROGRAMS

Ref: (a) NAVSEAINST 4120.7
(b) NSRP Document No. 0424, NIDDESC Piping Application Protocol
(c) NSRP Document No. 0425, NIDDESC Electrical/Cableway Application Protocol
(d) NSRP Document No. 0426, NIDDESC Heating, Ventilation, and Air Conditioning (HVAC) Application Protocol
(e) NSRP Document No. 0428, NIDDESC Outfit and Furnishings Application Protocol
(f) NSRP Document No. 0429, NIDDESC Ship Structure Application Protocol
(g) NAVSEA Technical Manual T0750-AH-PRO-010/CAD 2, 3D Product Modeling Practices Manual
(h) MIL-PRF-28000
(i) MIL-STD-1840

1. Purpose

a. To provide policy for developing, maintaining, and using three dimensional (3D) computer generated product models and associated data files in support of Navy ships and ship systems during all phases of design, acquisition, construction, conversion, repair, maintenance, modernization, and in-service life cycle support.

b. To insure data transfer mechanisms and standards are implemented to effectively provide for the exchange of 3D Computer Aided Design (CAD) product model data, including digital design and engineering information between Department of the Navy (DON) activities, commercial shipbuilders, suppliers, and other marine industry organizations.

2. Applicability and Scope

a. This instruction applies to all ship and ship system design, acquisition, construction, conversion, repair, maintenance, modernization, and life cycle support programs under the cognizance of NAVSEA and/or supporting shore activities.

b. This instruction applies to all ship and ship system design, acquisition, and construction under the cognizance of the Program Executive Officers (PEOs), Military Sealift Command (MSC), and the Department of Transportation (DoT) (e.g., U.S. Coast Guard) to the extent specified in written agreements between NAVSEA and those offices.

c. This instruction does not apply to propulsion plant systems and equipment under the cognizance of the NAVSEA Deputy Commander for Nuclear Propulsion (SEA 08). Product model data for these systems and equipment are excluded from this instruction. Such matters will be handled as directed by SEA 08.

d. This instruction applies to all ship and ships systems, including Commercial Off The Shelf (COTS) and Non-Developmental Items (NDI) procured during initial construction, backfit, upgrade, and by the Type Commanders. In-service equipment and systems are applicable, upon incorporation of a major upgrade or as designated by the cognizant equipment or system PEO.

3. Background

a. Reference (a) provided policy, responsibilities, and guidance for implementing Continuous Acquisition and Life-Cycle Support (CALS) in NAVSEA ships and weapon system acquisition and life cycle support programs. NAVSEA is applying advanced Computer Aided Design, Engineering, and Manufacturing (CAD/CAE/CAM) technology to support ship design, construction, and in-service life cycle support. Computer generated 3D product models of ships, including shipboard systems and equipment, are being developed, maintained, and used to improve processes, productivity, configuration management, and logistics support from initial design throughout the ship's life cycle.

b. The exchange of product model data between numerous activities throughout the ship life cycle is key to realizing the cost benefits of capturing information in electronic format. Specifying a neutral format for the exchange of CAD product model data will allow the transfer of product model information in a known content and format. The DON and marine industry, together with the concurrent requirements of other industries, led to the development of the international standard known as the Standard for the Exchange of Product Model Data (STEP). STEP is officially the Organization for International Standards (ISO) standard 10303, Industrial Automation Systems and Integration, Product Data Representation and Exchange. STEP development is supported in the United States (U.S.) by the IGES/PDES (Product Data Exchange using STEP) Organization (IPO).

c. A Navy/Industry Digital Data Exchange Standards Committee (NIDDESC) was formed in August 1986 to define a joint consensus on ship's product data and to incorporate these needs into national or international standards. NIDDESC has worked with the ISO Architecture, Engineering and Construction (AEC) Committee, to develop Application Protocols (APs), i.e., standards for the exchange of ship engineering information. References (b) through (f) represent the NIDDESC APs which have been documented and identified as National Shipbuilding Research Program (NSRP) specifications. Each AP provides a complete representation of a ship specific application area. These APs provide an external schema or information model to define the logical structure of a collection of data. The content and structure of a transferable product model data base is then described to other data base systems. Within the STEP arena, the schema is described in EXPRESS which is an ISO standard for a data specification language. EXPRESS is used for creating data structures for a database, solid geometry and topology, and configuration management.

d. NSRP specifications were established as a result of the NIDDESC effort and are available as interim standards in the U.S. These specifications were the baseline for the ISO international STEP ship APs that are underway. Undefined neutral exchange format application areas are marked To Be Assigned (TBA) and will be addressed in future product model data specifications.

AP Title	ISO Doc. No.	NSRP Doc No.
Ship Arrangements	10303 AP 215 (draft)	NSRP 0429
Ship Molded Forms	10303 AP 216 (draft)	NSRP 0429
Ship Piping Systems	10303 AP 217 (draft)	NSRP 0424
Ship Structures	10303 AP 218 (draft)	NSRP 0429
Ship Mechanical Systems	10303 AP 226 (draft)	TBA
Ship HVAC	TBA	NSRP 0426
Ship Outfitting & Furnishings	TBA	NSRP 0428
Electrical Design & Installation	10303 AP 212 (draft)	NSRP 0425
Ship Electronics Systems	TBA	
Ship Weapon Systems	TBA	
Library Parts Catalogs	13584 (draft)	

Ship electronics systems (e.g., computers, communications, radar, navigation, fire control), weapons systems (e.g., guns, missiles, torpedoes, aircraft), and library parts catalogs will be defined

in future interim U.S. specifications or they will be initiated as ISO APs.

There are additional STEP APs that address piece parts. Examples of these APs are:

AP Title	STEP Doc No.
Explicit Draughting	AP 201
Associative Draughting	AP 202
Configuration Controlled Design	AP 203
Electronic Printed Circuit Assembly: Design & Manufacturing	AP 210 (draft)
Electronic Printed Circuit Assembly: Test & Remanufacturing	AP 211 (draft)
Design & Manufacturing for Composite Structures	AP 222 (draft)
Exchange of Design & Manufacturing Production Information for Cast Parts	AP 223 (draft)

4. Discussion

a. A central theme in the Department of Defense (DoD) CALS philosophy of cost avoidance is the one time development of information in digital form and the exchange, transfer, or sharing of this digital information with other users, thereby avoiding the redundant creation of data. Product model data transfer will continue to be the DoD's and DON's greatest life cycle support challenge. This challenge stems from:

(1) Differences in the CAD product modeling systems in use by the major U.S. shipbuilders and manufacturers;

(2) Differences between CAD system capabilities and product model or neutral file exchange formats;

(3) Progressive loss of design intelligence as the data is transferred through dissimilar CAD systems and exchange formats;

(4) CAD systems are not similar in terms of capabilities to consistently process intelligent data;

(5) Differences in the CAD practices and methodologies of organizations.

b. A primary goal of NAVSEA's product model data acquisition strategy is to enable the exchange of this product data description through a standard industry format. Typically at

each stage of the ship life cycle, products are developed from information previously defined and provided to a number of different activities. Each CAD system in use at these different stages possesses a unique data base structure for storing geometric and non-geometric entities. The incompatibility of these proprietary data base structures makes it difficult to electronically transfer information directly from one system to another. A neutral file standard based upon an agreed to content and format specification is needed to move data between the different CAD systems. A translation capability is then required for each CAD system to move proprietary data to and from the neutral file standard.

c. A 3D CAD product model describes the complete data set (geometric and non-geometric information) necessary to define the ship or ship system for the purposes of engineering, design, analysis, manufacturing, testing, quality control, and life cycle logistics support. This includes geometric representations of the ship and its inboard arrangements including all the hull, superstructure, decks, compartment volumes, and detailed compartmentation which includes ship structure, equipment, components, arrangements, foundations, and distributive systems. For ship systems, this includes circuit card designs, castings, forgings, machined parts and other manufactured products. These geometric representations are directly associated to non-geometric attribute data such as engineering, configuration, manufacturing, and logistics type information needed to technically and logistically support the system throughout its life cycle. The association of geometric and non-geometric data may be encoded in proprietary data structures, file naming conventions, layering conventions, macro languages, application programming interfaces, parts libraries, or other means.

d. Reference (g) provides standards and procedures to NAVSEA CAD 2 users for development of 3D product models, including library part development and management. These standards and procedures will be maintained to ensure proper and consistent development, management, use, and exchange of 3D product model data by all NAVSEA CAD 2 system users.

e. The 3D CAD product model is envisioned to serve as the primary data source and integrator in the target CALS infrastructure, the Integrated Product Data Environment (IPDE). Life cycle use of product model data is planned to support feasibility studies, preliminary design, engineering studies and analysis, detail design, conversion, construction, repair,

maintenance, and in-service modernization. The Navy plans to acquire and share a complete 3D CAD ship product model to the designated ship class planning yard for all new ships. This 3D product model will be maintained to represent the ship's current configuration and logistics baseline throughout the service life of the ship. The product model will interface with various technical and logistics data repositories such as the Joint Engineering Data Management Information and Control System (JEDMICS) and the Advance Technical Information Support (ATIS) System. In the future, an integrated ship 3D product model is envisioned to provide numerous activities the capability to electronically share, access, centrally manage, and fully integrate a magnitude of digital data. This data will be available to the Fleet in support of their training, maintenance, repair, and operational requirements.

5. Definitions

a. Acquisition. The conceptualization, initiation, design, development, test, contracting, production or construction, deployment, logistics support, modification, and disposal of ships and ship systems, supplies, or services.

b. Attributes. Attributes are non-graphic data which relates geometric data to product model data. These include such information as item name, drawing number, part number, equipment function, national stock number, vendor name, weight, material, Hierarchical Structure Code (HSC), etc., tied to a specific geometric element, such as a coolant pump or fire control console.

c. Continuous Acquisition and Life-Cycle Support (CALS). A government and industry initiative that applies computer technology to digitize, store, retrieve, control and integrate related technical information and data.

d. Computer Aided Design (CAD). A process which uses a computer system to assist in the creation, modification, display, and visualization of a design.

e. Computer Aided Engineering (CAE). The use of computers to aid in engineering analysis and design. This may include the solution of mathematical problems, process control, simulation, design optimization, and execution of programs performing complex or repetitive calculations.

f. Computer Aided Manufacturing (CAM). The use of computers and numerical control equipment to aid in manufacturing

processes. This may include process planning, robotics, automation of testing, management functions, control, and product assembly.

g. Concurrent Engineering (CE). The simultaneous execution of actual and simulated product life cycle processes during product design and development phases.

h. Graphics. Presentation data required for the visualization of product information. This includes symbolic presentation such as line fonts, colors, cross hatching, etc., as well as realistic presentation such as projection, shading, etc.

i. Initial Graphics Exchange Specification (IGES). A neutral data format that allows for the digital exchange of geometry information among CAD and CAM systems and application programs (American National Standards Institute ASME Y14.26M).

j. Integrated Product Data Environment (IPDE). An integrated technical and logistics data environment providing a capability to store, manage, and share in accessible forms vast quantities of product (i.e., ship, systems, and equipment) information.

k. Logistics Support. The supply and maintenance of materiel essential for proper operation of a system in the fleet.

l. Product Data Exchange using STEP (PDES). The name given to the U.S. development effort in support of the international standard known as the Standard for the Exchange of Product Model Data (STEP). This standard is being developed for communicating complete product model data with sufficient information content so as to be interpretable directly by advanced CAD/CAM applications such as generative process planning, CAD directed inspection, and automatic generation and verification of automated manufacturing data.

m. Product Model. A three dimensional (3D) representation of a design that includes digital information required for full product definition. This definition includes the configuration of the end product at its current level of design maturity and the geometric and associated non-geometric product data information necessary for engineering, manufacturing, quality control and logistics support.

n. Product Model Data. The complete data set necessary to define an item for purposes of engineering, design, analysis, manufacture, testing, quality control, and life cycle logistics support. It includes 3D geometry, functional and physical identification information, associated data, and other non-graphical attributes.

o. Standard for the Exchange of Product Model Data (STEP). An international standard (ISO 10303) that specifies the public formats for the development and delivery of all product model data.

p. Systems Engineering. The application of scientific and engineering efforts to; (1) transform an operational need into a description of a system configuration that best satisfies the user's needs according to established measures of effectiveness, (2) integrate related technical parameters and assure compatibility of all physical, functional and technical program interfaces in a manner that optimizes the total system definition and design; and (3) integrate the efforts of all engineering disciplines and specialties into the total engineering effort.

6. Policy

a. Program managers acquiring new ships, shipboard systems, equipment, and components shall develop and maintain 3D CAD product model data (e.g., CAD, and engineering and logistics support data) for those ships, systems, equipment, and components. Product model data shall be developed or procured and delivered in accordance with one of the following two requirements:

(1) Product model data shall be in the native CAD format of the system the Navy project office is using. The CAD system the Navy project office is using could be the CAD system the contractor is using. It could also be the standard NAVSEA CAD system. This is currently the Intergraph Vehicle Design System (VDS) version 2.4 (or later) data format and Product Model Enhancement (PME) data structure. The 3D geometric content and construction methodology shall be in accordance with reference (g). Recognizing product model data is developed differently to satisfy different requirements, deviations shall be allowed under the following conditions:

(a) The deviation is required to accommodate modeling methodologies not covered by reference (g).

(b) Documentation of the 3D geometric content and construction methodology used to develop the product model shall be provided, and may be freely distributed at the discretion of NAVSEA.

or

(2) Product model data shall be in the NSRP data definition formats for neutral file exchange identified in references (b) through (f). If NSRP specifications have not been developed for a particular ship system such as a combat system, electronics system or mechanical system, then CAD data shall be in either 3D or 2D IGES format. This data shall satisfy IGES version 5.2 or later in accordance with reference (h) and be delivered in accordance with reference (i). Recognizing product model data standards are undergoing continuous improvement, deviations shall be allowed under the following conditions:

(a) The deviation is required to resolve deficiencies in the NSRP documents.

(b) The changes have been officially submitted for incorporation into the appropriate part of the ISO standard.

(c) The schema used to define the implementation shall be provided, and may be freely distributed at the discretion of NAVSEA.

b. Program managers involved in ship modernization and major system upgrades shall acquire product model data for in-service ship programs and associated shipboard systems, including equipment and components, that are under life cycle support. CAD data shall be developed or procured and delivered in accordance with one of the following three requirements:

(1) 3D product model data shall be in the native CAD format of the system the Navy project office is using. The CAD system the Navy project office is using could be the CAD system the contractor is using or the standard NAVSEA CAD system. (This is currently the Intergraph Vehicle Design System (VDS) version 2.4 (or later) data format and Product Model Enhancement (PME) data structure). The 3D geometric content and construction methodology shall be in accordance with reference (g).

or

(2) 3D product model data shall be in data definition formats for neutral file exchange in accordance with references (b) through (f). Recognizing product model data standards are undergoing continuous improvement, deviations shall be allowed under the following conditions:

(a) The deviation is required to resolve deficiencies in the NSRP documents.

(b) The changes have been officially submitted for incorporation into the appropriate part of the ISO standard.

(c) The schema used to define the implementation shall be provided, and may be freely distributed at the discretion of NAVSEA.

or

(3) If cost effective, CAD data can be acquired in either 3D or 2D IGES format. This data shall satisfy IGES version 5.3 or later in accordance with reference (h) and be delivered in accordance with reference (i).

7. Responsibilities

a. Deputy Commander for Fleet Logistics Support (SEA 04)

(1) Establish overall NAVSEA planning, policy and guidance for information technology to include budget, security, architecture, and authority for ship 3D CAD product model data acquisition and use.

(2) Develop, distribute, maintain, and facilitate implementation of the future NAVSEA integrated Information Technology (IT) architecture, ensuring that the current NAVSEA enterprise-wide IT infrastructure and architecture is operational, efficient, and consistent with Navy, DoD, and commercial standards.

(3) Participate in digital 3D CAD product model data transfer standards (i.e., NSRP/STEP file formats) development efforts and demonstration projects.

(4) Develop and maintain reference (g) and ensure compliance by all NAVSEA CAD 2 System users.

(5) Maintain a centralized product model master library of CAD 3D elements and ensure product model data is complete and made available to all CAD users.

(6) Ensure that the NAVSEA Standard CAD System contract provides adequate training courses for users.

(7) Ensure that the NAVSEA Standard CAD System contract provides systems that are compliant with the 3D product model neutral file exchange and 2D drawing exchange standards.

(8) Coordinate integration of all processes, applications, and databases to achieve interoperability of information systems for all phases of acquisition and service life support.

b. Deputy Commander for Ship Design and Engineering (SEA 03) and Deputy Commander for Warfare Systems (SEA 05)

(1) Develop 3D CAD product model data in compliance with reference (g) to support early stage design, analysis, and engineering efforts.

(2) Ensure the incorporation of 3D CAD product model data requirements into new ship specifications.

(3) Ensure required CAD training is provided to all personnel assigned to support 3D CAD product modeling for ship design functions.

(4) Ensure the development and update of 3D CAD product model data transfer standards (i.e., IGES, NSRP and STEP file formats).

c. Commander Naval Surface Warfare Center (NSWC), Commander Naval Undersea Warfare Center (NUWC), Deputy Commander for Surface Ship (SEA 91), Deputy Commander for Submarines (SEA 92), and other NAVSEA Program Managers and Supporting Activities

(1) Plan, program, budget, and manage required resources for implementing 3D CAD product modeling methodology, if applicable.

(2) Develop or procure and deliver 3D CAD product model data per paragraph 6.

(3) Ensure proper and successful implementation of 3D CAD product model data requirements in contracts, solicitations, plans and other program documents.

(4) Include and define in applicable configuration management, CALS, Integrated Logistics Support (ILS), and other program plans those specifications and other documents that are used to develop and maintain 3D CAD product model data.

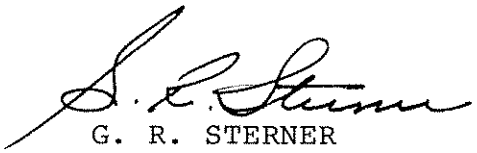
(5) Use 3D CAD product model data to support new ship acquisition as well as ship design, alteration planning, repair, maintenance, execution, and life cycle logistics support.

(6) Ensure required CAD training is provided to all personnel assigned to support 3D CAD product modeling for ship design and in-service support functions.

(7) Link existing technical and logistics data repositories to 3D CAD product models whenever practicable and cost effective.

(8) Define the requirements for developing, procuring, and validating ship 3D CAD product models and supporting digital data in all applicable ship acquisition plans.

(9) Ensure engineering and logistics support organizations are supported with the proper tools to develop, maintain, transfer, review, validate, and manipulate ship 3D CAD product model data.



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