



Developed under NSRP Systems Technology Panel

NSRP Systems Technology Panel Project

**Publish ISO Technical Corrigenda for ISO 10303-215,
10303-216 and 10303-227**

Final Report

September 30, 2007

Category B Data - Approved for public release; distribution is unlimited.

**Product
Data
Services
Corporation**

Introduction

The STEP Shipbuilding Standards

Over the last 15 years, NSRP, the Navy, DARPA, and the U.S. Shipyards have supported development of U.S. and ISO (International Organization for Standardization) standards for the exchange of Ship Product Model design, simulation, and manufacturing data. These efforts grew out of the realization during the Seawolf and DDG acquisition programs that the development of direct data translation capabilities between the Navy and its various contractors was prohibitively expensive and repetitive as every new acquisition program with different partners and different CAD/CAM tools required complete redevelopment of the software to implement production data exchanges for design and manufacturing. The Navy Industry Digital Data Exchange Standards Committee (NIDDESC) was formed in 1987 as a cooperative effort by the major U.S. Shipyards and the Navy to address the need to share ship design and construction data between co-production partners and with the customer. Similar groups were formed in other industries that were facing the same challenges. In the early 1990's the various industry groups came together to cooperatively develop an integrated group of data sharing standards within ISO.

The STEP (STandard for the Exchange of Product model data) series of standards, published as parts of the ISO 10303 (STEP) and ISO 13584 (Part Libraries) standards, provide standardized data model content and exchange methods for a broad range of manufacturing industries, from printed circuit boards to aircraft, automobiles, and ships. *Figure 1* illustrates the wide range of industrial data supported by the STEP series of standards. Some of these standards are applicable across many or all industries, and some are published as more industry-specific Application Protocols to standardize the requirements for sharing data within a particular industrial sector. *Figure 2* illustrates those portions of the STEP standards developed or used by contributors to the ISO Shipbuilding Committee, many of whom are also members of the NSRP Systems Technology Panel.

The successful sharing of product model data requires that all parties utilize the same underlying data schemas in the development and deployment of translator software. These schemas document the requirements and the technical content of the product model data to be exchanged. The shipbuilding industry has developed and adopted the ISO-standardized STEP Shipbuilding Application Protocols as the standard data schemas for sharing ship product model data. Several of the standards which support ship design and manufacturing, namely 10303-215, 10303-216, 10303-218, and 10303-227 Edition 2 were completed as International Standards in 2003-2005. In parallel, Shipyard, Navy and CAD/CAM Vendor teams working first within the DARPA MariSTEP program and later the NSRP Integrated Shipbuilding Environment (ISE) program developed prototypes of the CAD/CAM translators required to support some of these emerging standards.

As the MariSTEP and ISE programs have developed prototype translator software to implement these standards, some editorial corrections and technical modification of the standards have been identified that will make them more complete and more useful. This Project resolved the technical issues and produced the ISO documentation to incorporate these changes into the International Standards.

APPLICATION PROTOCOLS AND ASSOCIATED ABSTRACT-TEST SUITES	
<p>I 201 Explicit draughting [ATS 301 = X] I 202 Associative draughting [X] I 203 Configuration-controlled design (c2=I, a1=I) [X] I 204 Mechanical design using boundary rep [I] X 205 Mechanical design using surface rep [W] X 206 Mechanical design using wireframe [X] I 207 Sheet metal die planning and design [I] X 208 Life-cycle product change process [X] I 209 Composite & metal structural anal & related design [X] I 210 Electronic assy, interconnection & packaging design [X] X 211 Electronic P-C assy, test, diag, & remanuf [X] I 212 Electrotechnical design and installation [C] I 213 Num control (NC) process plans for mach'd parts [X] X 214 Core data for automotive mech design processes (e2=E) [F] E 215 Ship arrangement [X] E 216 Ship moulded forms [X] X 217 Ship piping [X] E 218 Ship structures [X] X 219 Dimension inspection [X] O 220 Proc. plg, mfg, assy of layered electrical products [X]</p>	<p>C 221 Functional data & their schem rep for process plant [X] X 222 Design-manuf for composite structures [W] X 223 Exch of design & mfg product info for cast parts [I] I 224 Mech pdt def for p. plg using mach'n'g feat (e2=X, e3=A) I 225 Building elements using explicit shape rep [C] \ [X, I] X 226 Ship mechanical systems [C] I 227 Plant spatial configuration (e2=C) [X] X 228 Building services: HVAC [X] X 229 Design & mfg product info for forged parts [X] X 230 Building structural frame: steelwork [X] X 231 Process-engineering data [X] I 232 Technical data packaging: core info & exch [I] W 233 Systems engineering data repr (to be PAS 20542) [X] X 234 Ship operational logs, records, and messages [X] W 235 Materials info for des and verif of products [X] W 236 Furniture product and project data [W] W 237 Computational Fluid Dynamics A 238 Computer numerical controllers W 239 Product life-cycle support W 240 Process plans for machined products</p>

ignell, 89-Oct.-23; rev. 03-04-07. Origin: ISO 10303 Editing Committee. On-line: <http://www.nist.gov/sc5/soap/>

I 1 Overview and fundamental principles
 I 11 EXPRESS language ref man. (c1=I, c2=C, e2=C, e3=X) ISO 20303=X, a1=X
 I 12 EXPRESS-I language ref man (Type 2 tech report, not a 10303 part)
 X 13 Architecture and Methodology reference manual
 E 14 EXPRESS X Language reference manual

COMMON RESOURCES (with 13584-20 logic model of expr.(I) and 15531-42 Time (W))

APPLICATION MODULES (Technical specifications)	Legend: TS Status
For status of the modules access the file via the SOAP home page.	0-10 = O = prop. -> apvl for ballot 10-20 = A = NP blt circ. -> NP apvl 20-60 = D = DTS dev. -> reg as TS >60 = T = TS Published

INTEGRATED-APPLICATION RESOURCES	
<p>I 101 Draughting (c1=I) X 102 Ship structures X 103 E/E connectivity I 104 Finite element analysis I 105 Kinematics (c1=I, c2=I)</p>	<p>X 106 Building core model C 107 Finite-element analysis definition relationships C 108 Prmetizat'n & Constraints for expl geom prod mdl C 109 Assembly model for products W 110 Mesh-based computational fluid dynamics</p>

INTEGRATED-GENERIC RESOURCES	
<p>I 41 Fund of pdct descr & spt (e2=I, c1=I) I 42 Geom & top rep (c3=I, e2c1=I, e3=F) 43 Repres specialization (e2=I, c1=I, c2=I) 44 Product struct confg (e2=I, c1=I) 45 Materials (c1=I) 46 Visual presentation (c1=I, c2=I) 47 Tolerances (c1=I) X 48 Form features I 49 Process structure & properties</p>	<p>I 50 Mathematical constructs E 51 Mathematical description W 52 Mesh-based topology W 53 Numerical Analysis C 54 Classification Set theory A 55 Procedural and hybrid represent. W 56 State W 57 Expression extensions A 58 Risk</p>

APPLICATION-INTERPRETED CONSTRUCTS	
<p>I 501 Edge-based wireframe I 502 Shell-based wireframe I 503 Geom-bounded 2D wire frame I 504 Draughting annotation I 505 Drawing structure & admin. I 506 Draughting elements I 507 Geom-bounded surface I 508 Non-manifold surface I 509 Manifold surface I 510 Geom-bounded wireframe I 511 Topological-bounded surface</p>	<p>I 512 Faced B-re presentation I 513 Elementary B-re p I 514 Advanced B-re p I 515 Constructive solid geometry X 516 Mechanical-design context I 517 Mech-design geom presentation (c1=I) I 518 Mech-design shaded presentation I 519 Geometric tolerances (c1=I) I 520 Assoc draughting elements @521 Manifold sub-surfaces E 522 Machining features A 523 Curve swept solid</p>

IMPLEMENTATION METHODS	
<p>I 21 Clear-text encoding exch str (c1=I, e2=I) I 22 Standard data access interface I 23 C++ language binding (to #22) I 24 C language binding (to #22)</p>	<p>C 25 EXPRESS to OMG XMI X 26 IDL language binding (to #22) I 27 JAVA language binding (to #22) @28 XML rep for EXPRESS-schemata & data X 29 Ltwrt Java binding (to #22) \ (DTS)</p>

CONFERENCE TESTING METHODOLOGY & FRAMEWORK
 I 31 General concepts
 I 32 Requirements on testing labs and clients
 X 33 Structure and use of abstract test suites
 I 34 Abstract test methods for Part 21 implementation
 C 35 Abstract test methods for Part 22 implementation

<p>Legend: Part Status (E, F, I safe to implement) 0=O=Preliminary Stage (Proposal -> appr for NP ballot) 10=A=Proposal Stage (NP ballot circ. -> NP approval) 20=W=Preparatory Stage (Wkg Draft devel. -> CD regis) 30=C=Committee Stage (CD circulation -> DIS regis)</p>	<p>40=E=Enquiry Stage (DIS circ. -> FDIS registration) 50=F=Approval Stage (FDIS circ. -> Int'l Std regis) @=At ISO, approved for publication (ISO status 40.95 or 50.99) 60=I=Publication Stage (Int'l Std published) 98=X=Project withdrawn</p>
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Figure 1 – The ISO STEP Series of Standards

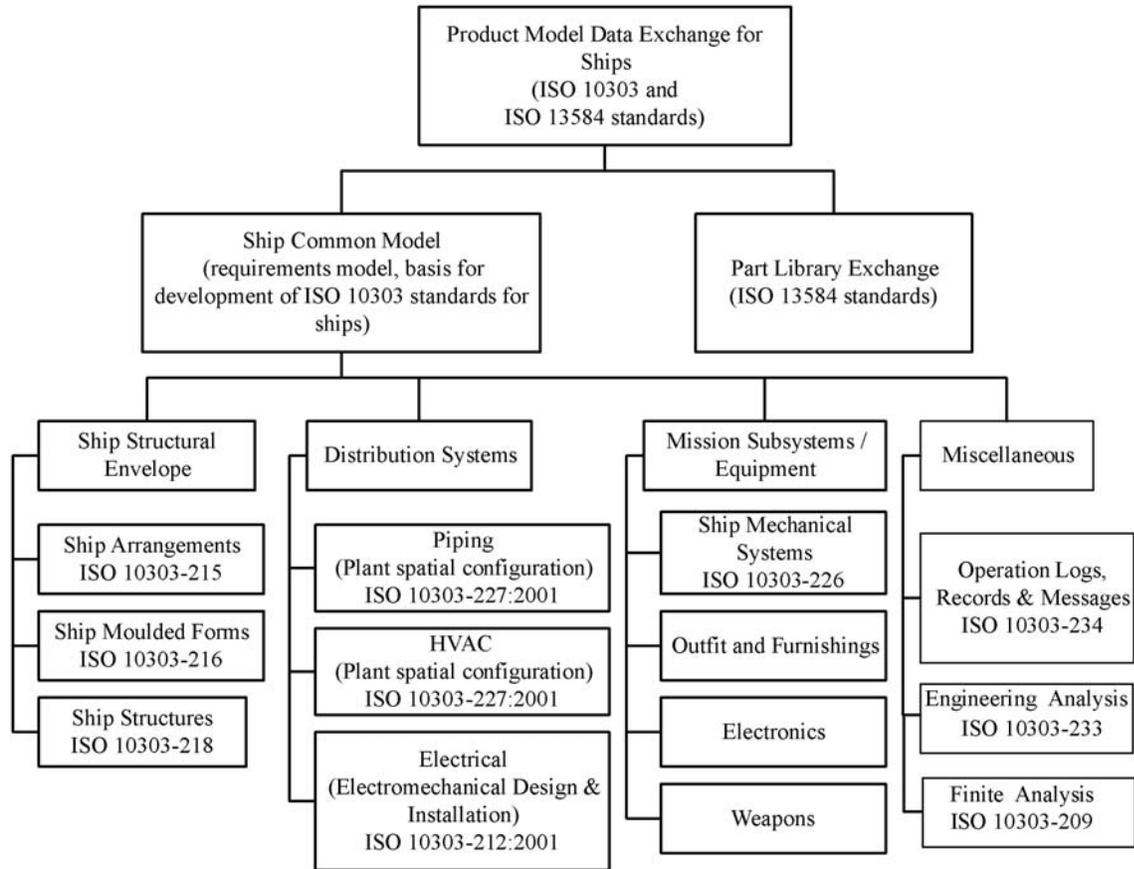


FIGURE 2 – The ISO STEP Shipbuilding Standards

The ISO STEP Application Protocols for the exchange of Ship Moulded Forms (ISO 10303-216:2003), Ship Arrangement (ISO 10303-215:2004) and Plant Spatial Configuration (ISO 10303-227:2005) were developed by members of the NSRP Systems Technology Panel, the NSRP ISE program and the ISO TC184/SC4 T23 (Shipbuilding) group. All were published as International Standards by ISO, with the final editing and publication of the standards accomplished under the previous NSRP Harvest project and NSRP ISE program.

ISO 10303-216 specifies the data content and method of exchange for a Ship's surface geometry and intact stability. *Figure 3* illustrates the data types supported by ISO 10303-216.

ISO 10303-215 specifies the data content and method of exchange for a Ship's compartmentation, weight distribution and damaged stability. *Figure 4* illustrates the data types supported by ISO 10303-215.

ISO 10303-227 specifies the data content and method of exchange for a Ship's Piping, HVAC, Cableway, and Mechanical Systems. *Figures 5 through 8* illustrate the data types supported by ISO 10303-227.

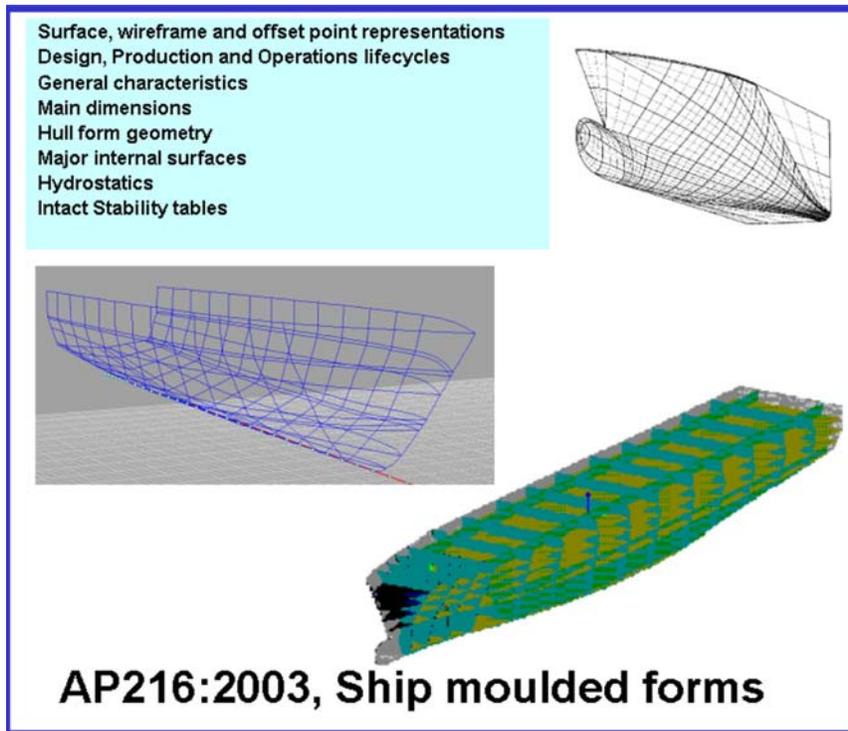


FIGURE 3 – ISO 10303-216 Ship moulded forms

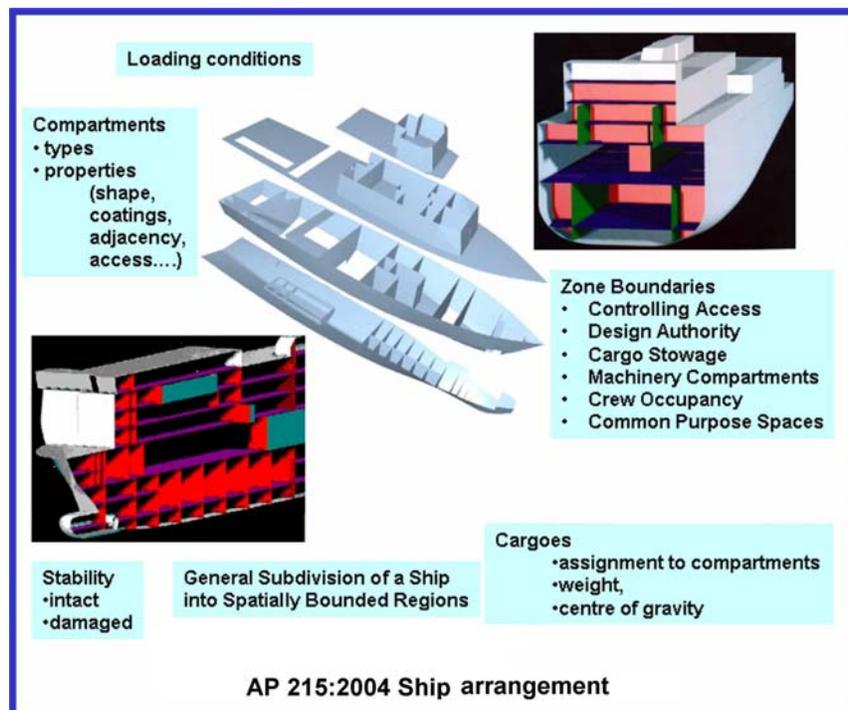


FIGURE 4 – ISO 10303-215 Ship arrangement

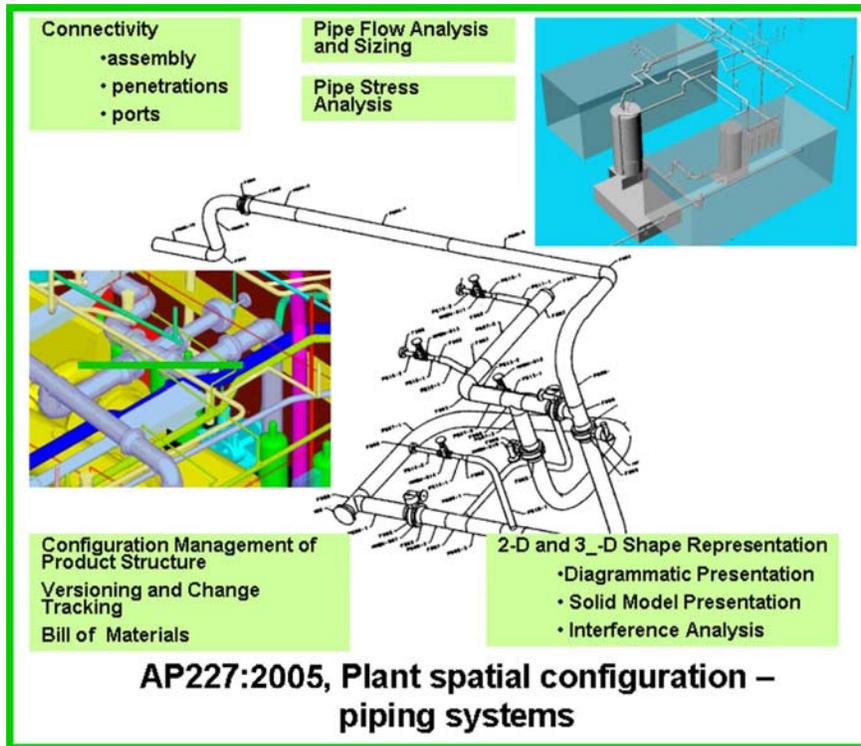


FIGURE 5 – ISO 10303-227 Plant spatial configuration – Piping

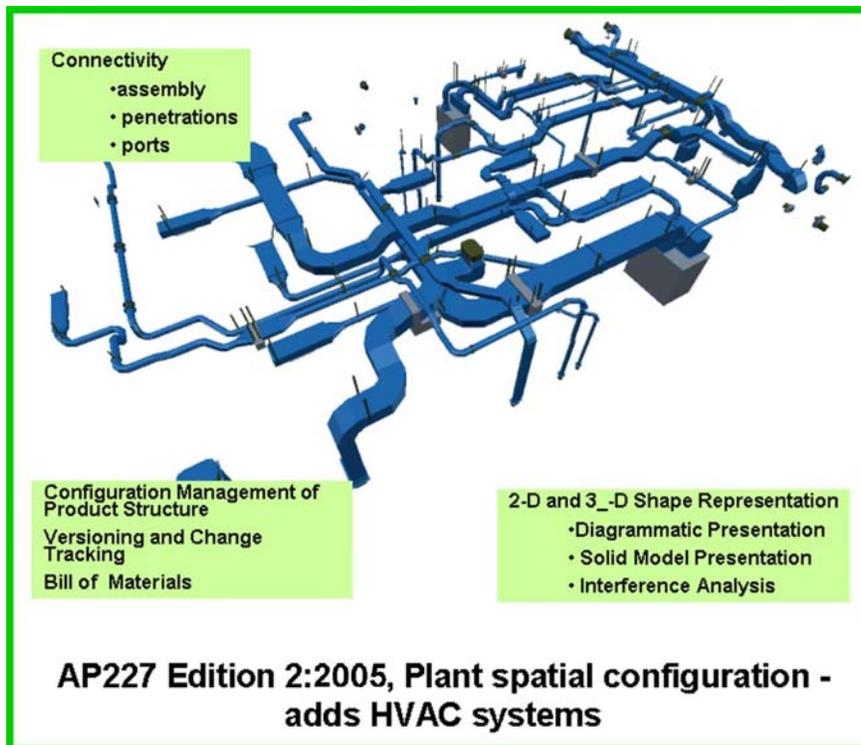


FIGURE 6 – ISO 10303-227 Plant spatial configuration - HVAC

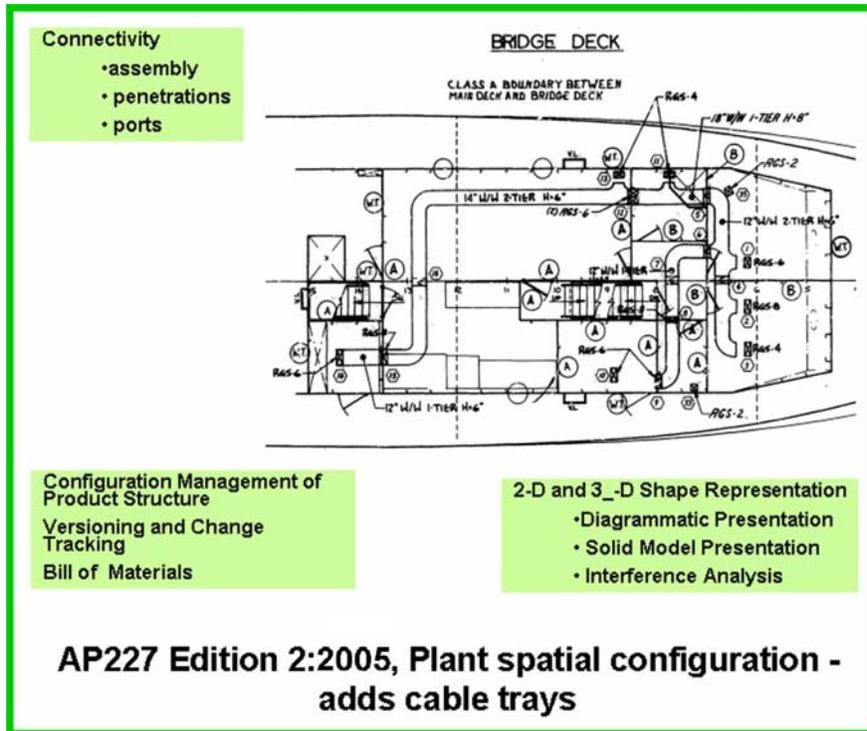


FIGURE 7 – ISO 10303-227 Plant spatial configuration – Cable trays

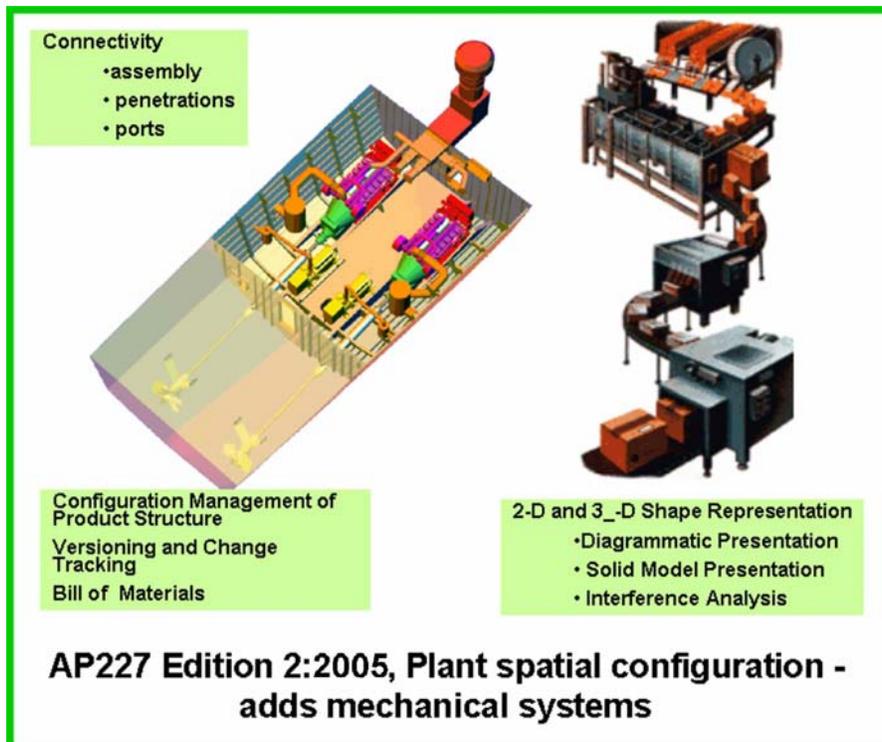


FIGURE 8 – ISO 10303-227 Plant spatial configuration - Mechanical

ISO 10303-218 specifies the data content and method of exchange for a Ship's Structural Systems and parts. Though not addressed in the current project, it is included here for completeness. *Figure 9* illustrates the data types supported by ISO 10303-218.

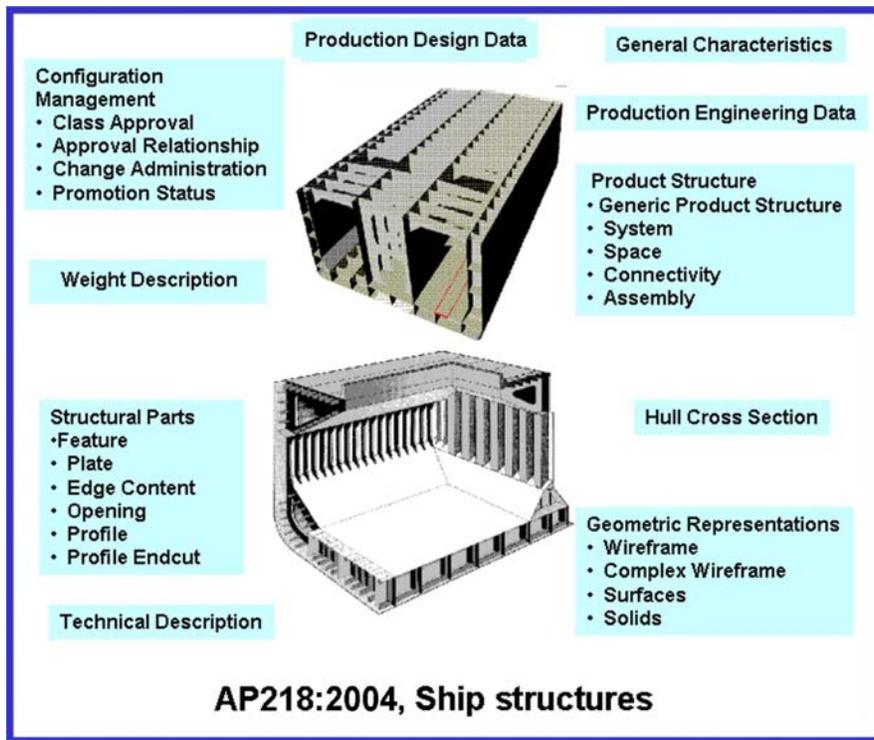


FIGURE 9 – ISO 10303-218 Ship structures

Maintenance of the ISO STEP Shipbuilding standards

As noted above, during the several phases of NSRP ISE program, several shipyards, the Navy, and their CAD vendors have developed software implementations to exchange ship design product model data in compliance with these standards. One of the tasks of the ISE program was to validate and recommend corrections and modifications to the ISO standards where necessary to assure successful future exchange of data among the shipyards and the Navy. The editorial and technical issues identified by the ISE Team as well as other reviewers and users of the Shipbuilding standards were documented as ISO Standard Enhancement and Discrepancy System (SEDS) reports for necessary corrections or recommended modifications to the standards.

This NSRP Panel Project has completed the technical issue resolution and has developed the ISO amendment documents for ISO 10303-215, ISO 10303-216 and ISO 10303-227 to incorporate the corrections and modifications identified by the ISE Team and others into the Shipbuilding standards. The appropriate documents have been prepared for publication by the ISO Central Secretariat as Technical Corrigenda to the International Standards.

The technical work consisted of a review of the outstanding STEP Standard Enhancement and Discrepancy System (SEDS) issues that had been submitted against the three International Standards, and resolution and documentation of the technical solutions to these issues as an ISO Technical Corrigendum document. Outstanding issues and proposed solutions were discussed with members of the ISO TC184/SC4 T23 (Shipbuilding) Team on several conference calls and at meetings of the NSRP ISE-6 project and the NSRP Systems Technology Panel.

Deliverable 1 of this project, the Technical Corrigendum for ISO 10303-216 (Application Protocol for Ship moulded forms) has been published by ISO and is publicly available from the STEP website (<http://www.tc184-sc4.org>). Deliverable 2, the Technical Corrigendum for ISO 10303-215 (Application Protocol for Ship arrangement) was submitted to ISO in July, 2007, and is expected to be published by ISO shortly. Deliverable 3, the Technical Corrigendum for ISO 10303-227 (Application Protocol for Plant spatial configuration) was submitted to ISO at the end of the project, and is expected to be published by ISO before the end of 2007.

Benefits of maintaining the Standards

Most of the modifications made to the ISO Shipbuilding standards were to correct errors and omissions identified during development of the NSRP ISE STEP translators. The recommended corrections were made in the ISE software as it was developed, with these lessons learned fed back for maintenance correction in the standards in this Panel Project. Revising the published ISO documentation to match that used for recent ISE software development assures that future translators developed by non-ISE participants will interoperate with the ISE versions of the product model schemas.

In addition, NAVSEA Instruction 9040.3 recommends contractor delivery of data in accordance with the ISO STEP Application Protocols. Revising the ISO standards to include the corrections, changes, and lessons learned from the NSRP ISE program brings the existing ISE translator software into compliance with the NAVSEA Instruction for potential use on current and future ship programs.