Journal of Advanced Research in Ocean Engineering 4(3) (2018) 96-104
http://dx.doi.org/10.5574/JAROE.2018.4.3.096

Schema of Maintenance Data Exchange and Implementation Applied To Ship & Offshore Platform

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(Manuscript Received July 7 2018; Revised August 5, 2018; Accepted August 30, 2018)

Abstract

The importance of data management for the efficient maintenance and operation of offshore structures is becoming increasingly important. This paper has discussed the data schema and business rules that standardize the data exchange between ship design, operation and maintenance. Technical documentation that meets the international standards of ShipDex and S1000D for exchanging the operation and management data in neutral or standard formats has been introduced into the life cycle management of ships. The schema of the data exchange is represented by XML (eXtensible Markup Language) and the lifecycle data is implemented by a structured document. Lifecycle data is represented as data modules defined by XML schema. Given the feasible data generation, an example of a technical document is introduced by a general XML authoring tool.

Keywords: ShipDex, S1000D, XML, Lifecycle data, Data Exchange, Maintenance data

1. Introduction

The manufacturing industry faces a variety of data exchange requirements arising from design, production, operation and maintenance. Product lifecycle (MOL) and end-of-life (EOL) product data has received much attention in many industries including manufacturing, maintenance / recycling and recycling due to concerns about maintenance and operational costs and resource recycling (Um et al., 2008). To address these problems, Product Lifecycle Support (PLCS), Asset Lifecycle Management (ALM), Computerized Maintenance Management System (CMMS), and Enterprise Resource Planning (ERP) have been applied to maintenance and operational and management processes. These technologies enable partial use of extended enterprise-wide lifecycle data and operational information, from design to product disposal. Since marine vessels have a lifespan of more than 20 years, there are many opportunities to apply lifecycle support in MRO (Maintenance, Repair and Overhaul). With the advent of PLCS in marine and offshore structures, shipbuilders and equipment manufacturers are in charge of generating lifecycle data, including maintenance data. Nonetheless, it will be important to exchange lifecycle data efficiently. The emergence of technical documentation on life cycle data has been driven by the need to support complex products over an extended life cycle. The main standard specification for technical

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documents is the S1000D, which comes from the Air Transport Association (ATA) 100 specification. S1000D requires the information layout in a consistent order, including the structure of systems, subsystems and components. CALS (Computer Aided Acquisition and Logistic Support) is recommended as a technical document format delivered to defense systems by the US Department of Defense. This requirement is achieved through the structured documentation standards that provide a consistent structure and content element modification essential for efficient identification, management and integration of data in a computing environment (Greenough and Williams, 2007). The international standards for data exchange are needed to develop lifecycle data for marine vessels, particularly technical publications. Maintenance costs of ship operations are affected by the efficient integration of this lifecycle information. Some industries adopt a new lifecycle support standard for technical publication: An international standard specification for technical publications utilizing a common source Database (S1000D) and Ship Data Exchange (ShipDex). The specification adopts ISO, CALS and W3C standards. In fact, it uses STEP (Standard for the Exchange of Product Model Data) AP239, which is one of the standard formats (Briggs, et al., 2006; AIA, 2008; ARA et al., 2016). STEP is intended to handle a much wider range of product-related data covering the product's entire life cycle (Hu, et al., 2006; Pratt, 2005). However, STEP focuses on design data rather than operational and maintenance information. The ShipDex specification applies to lifecycle data exchange of ships and offshore structures. The purpose of the ShipDex and S1000D specifications is to support technical documentation on product lifecycle data during the MOL and EOL. ShipDex describes an architecture that includes an XML-based structured model, product lifecycle data sharing and maintenance data for design information exchange. ShipDex's specification states that technical information such as descriptions, faults, maintenance plans and personnel can be stored and organized by the data module (Bury, 2008).

The objective of present paper is to study the implementation of life cycle document in ship and offshore MRO processes while explaining the schema and data exchange of technical documents for exchanging ship lifecycle support data using international standards. This paper also introduces issues related to generate PLCS technical data from product information in accordance with the S1000D standard. ShipDex for technical documentation is based on a structured architecture of XML. The integration of ShipDex documents with product lifecycle support systems is discussed. Focus on the DataExchange (DEX)-compliant schema so that lifecycle data can be published in a synchronized manner with product information. Section 2 introduces the structure of ShipDex and its basic principles. This paper consists of technical documents issued using ShipDex. This document explains how DEX supports lifecycle data documents, including information models, data modules, publishing documents using XLM, and processes for reusable lifecycle data.

2. Architecture of ShipDEX

2.1 Definition of ShipDex

The need to develop a common protocol for exchanging lifecycle data comes from the fact that shipping companies are receiving technical documents or lifecycle data in a variety of formats and structures. This situation has caused some problems in maintenance in terms of information exchange. ShipDex is a pseudo-standard and business rule developed to standardize the production and exchange of technical and logistic data throughout the lifecycle within shipbuilding and ship operations. The ShipDex protocol follows the specifications of AeroSpace and Defense Industries Association of Europe (ASD) S1000D in issue 2.3 (www.s1000d.org). The S1000D is an international standard for the production and procurement of technical publications. There are many data module types which are appropriate for utilization of all technical information required in operation and maintenance of the product (Choi et al., 2013).

ShipDex has been developed by maritime software company SpecTec, Co. Ltd. and equipment manufacturers including Man Diesel, Alfa Laval, and Yanmar Co., Ltd. It intends to improve data exchange by providing open XML-based standards. ShipDex is based on the ASD S1000D and is used to manage the efficiency of information exchange between ship owners, shipyards, manufacturers, classification societies, IT companies and service providers (see Fig. 1). As these ShipDex rules are based on S1000D, any modifications to S1000D rules need to be updated and ShipDex rules may also need to be modified accordingly or may be modified regardless of S1000D (Choi et al., 2013)

2.2 Components of DEX

Because both the S1000D and ShipDex documents are represented by XML standard, the data module can be information-centric rather than document-centric using a common source database to store content as shown in Fig. 2. Product information is achieved by Data Module (DM) which is defined as 'the smallest self-contained information unit'. All the data modules applicable to the product information can be collected and managed in a database, which is referred to the Common Source Database (CSDB). ShipDex document is generated though three stages, i.e. (1) data verification/mapping, (2) data storage/management, and (3) publication phase.

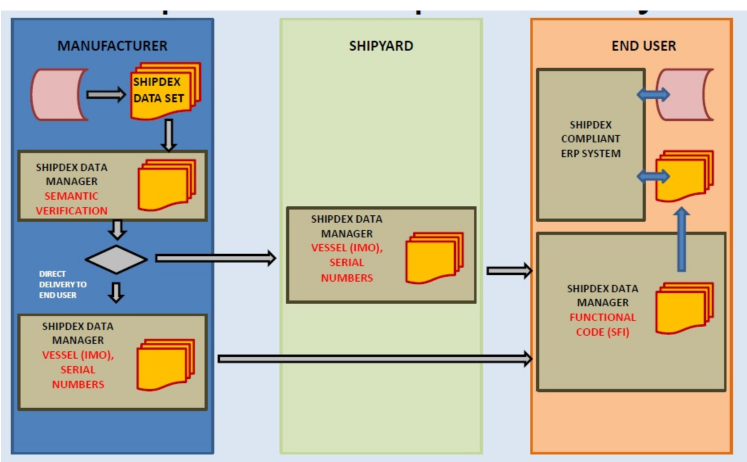


Fig. 1 Delivery process of ShipDex document

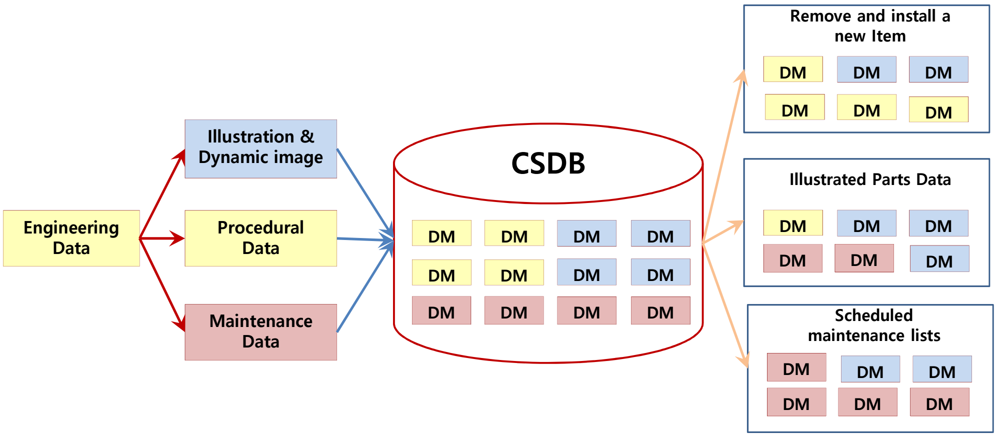


Fig. 2 Publication procedure of data module

All the information is expressed by XML macro elements called a Data Modules (DM). Each DM contains data supplied in XML format and can refer external information objects, e.g. other DMs, other documents, illustrations, 3-D model, multimedia objects. Documents, e.g. IETP, IETM, and SCORM can be generated applying parsers and style sheets for DM since DM contains data expressed by XML format.

2.3 Schema of Data Module

The basic unit of DEX is the Data Module (DM). A DM is an entity stored in a common source database (CSDB). DMs contain a number of different types of technical information. The DM can be presented by an object class as shown in Fig. 3. Fig. 4 also shows the schema of DM expressed by XML. A data module contains the following information:

- Identification: Data Module Code, title, issue number, issue date, language
- Status: responsible Company, applicability, technical standard, quality assurance status, skill, reason for update etc.
- Content: Description and operation, Maintenance procedure, Troubleshooting, Illustrated parts data, Service Bulletin

The data module can support the following types of content and constructs as shown in Fig. 6.

- Description: The module for providing a guideline and suggestions in a procedure of assembly and disassembly when a machine needs the maintenance
- Troubleshooting: The module for predictable failure in a machine and solutions
- Illustrated Parts data (IPD): The module for illustrational information of machine components
- Service bulletin: The module for tracking changes in a machine of an internal information and its history

The identification and status section are the first attribute of data module. It contains identification data such as data module code, title, issue number, language and status data. Fig. 6 shows the schema of the identification and status section. It provides data that can be used for:

- Management of the use of applicability
- Management of the quality control process
- Management and control of retrieval functions
- Automatic compilation of sets or subsets of information

Contents section is composed of maintenance planning information, description, operator information, text, and illustration (see Fig. 7).

To provide the creation of a web-based XML management, XML of DM requires the URNs connecting resources created under the specification in order to retain unique, permanent, location-independent names for the resources.

URN : S1000D : {subid} - {subcode} - {subext} URN: S1000D : DMC-AE-A-07-05-0000-00A-040A- A_I-001_L-EN {subid} = DMC, The code is a Data Module Code {subcode} = AE-A-07-05-0000-00A-040A-A, String in DMC syntax {subext} = _I-001_L-EN, the first issue in English.

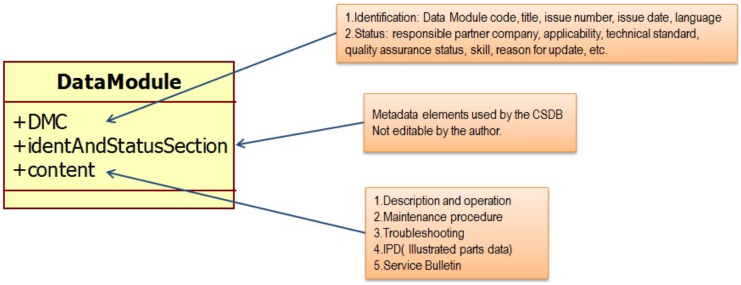


Fig. 3 Data Module express & schema

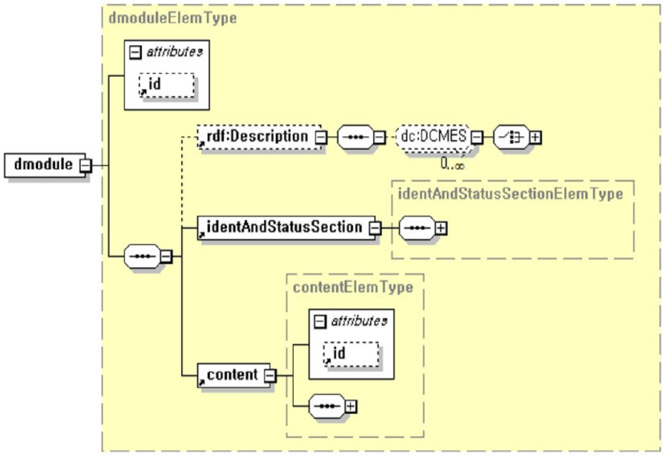


Fig. 4 XML schema of data module (S1000D, 2008)

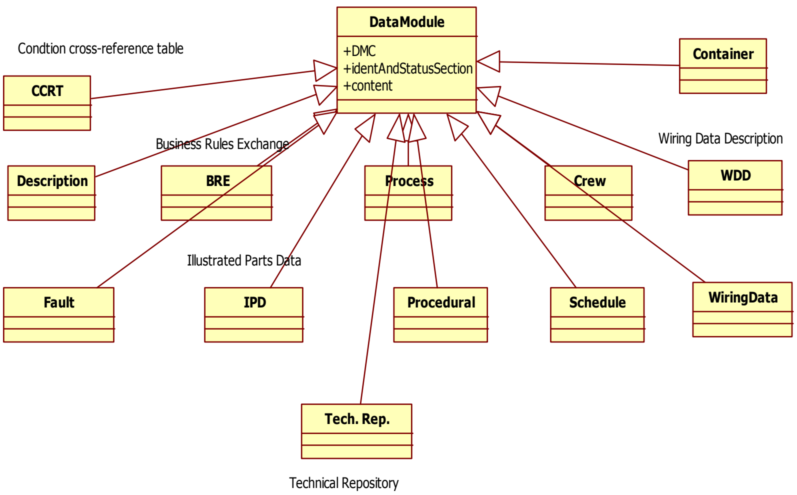


Fig. 5 Inherited classes of data module

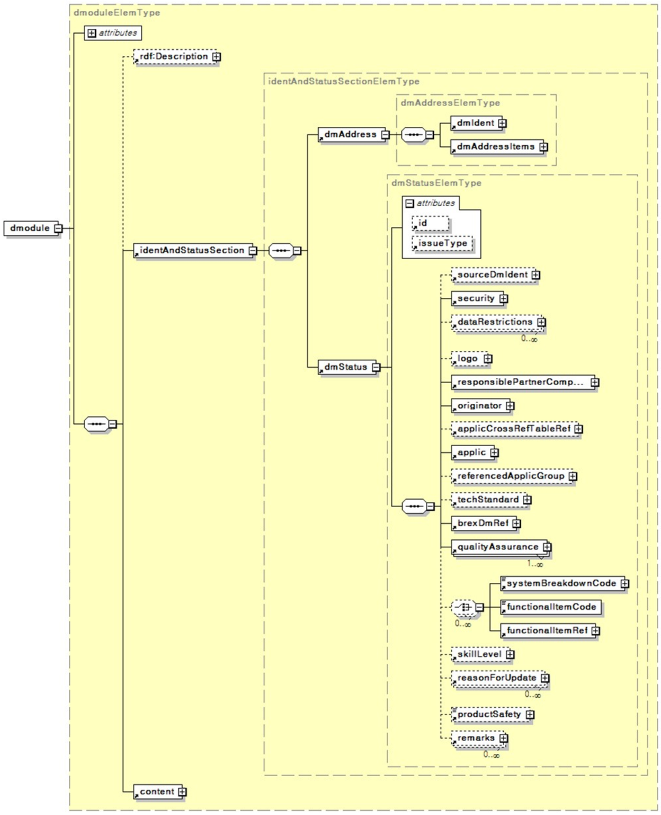


Fig. 6 Schema of Identification and status section (S1000D, 2008)

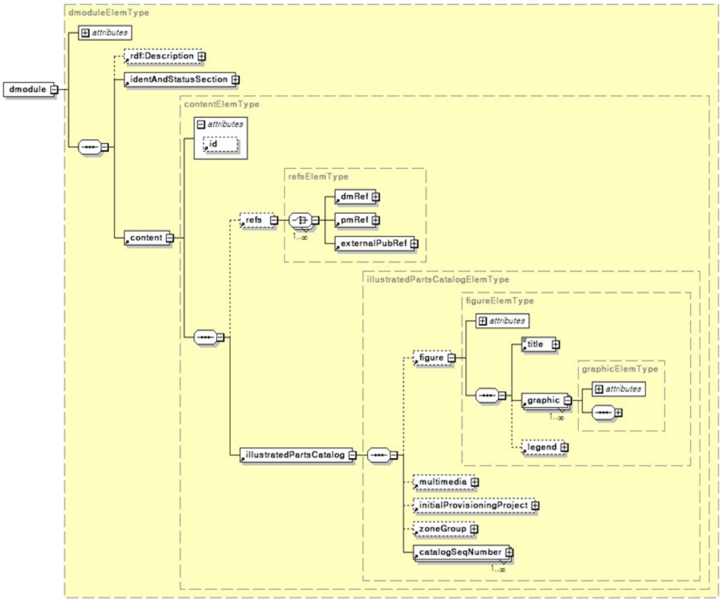


Fig. 7 Schema of contents section (S1000D, 2008)

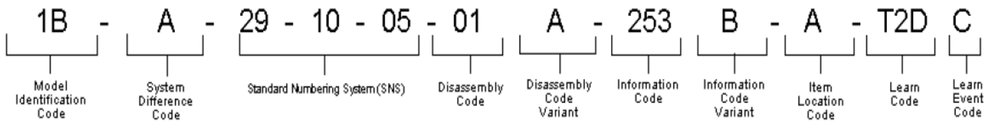


Fig. 8 Example of Data module code

2.4 Data Module Code

The Data module code (DMC) provides unique code to identity content and each data module. DMC can be defined by 17 to 37 numbers of alphanumeric codes for clear classification. An example of DMC shown in Fig. 8 provides a naming convention for DMs. An example of a DMC that provides a naming convention for DM is shown in Figure 8, where each key element provides a specific meaning associated with the content. Detailed specifications can be found in Vatteroni (2008).

2.5 Document Publication

The flexibility of DEX is that multiple media types can be transformed into XML. Because XML document has the flexible data structure representing the information, DMs are common enough to support multiple data types. Therefore, the desired publishing process can be selected based on contract and customer requirements. The publication process represents the data to be processed from the information to the DM and supports a hierarchical structure to present the document. Fig. 9 shows the publication process of DEX and authoring tools that can support each process. ShipDex data generation is the same as S1000D data generation, so we used Adobe Framemaker 10, which supports the S1000D specification, to generate DM and documents. Framemaker supports DM creation for crew, description, procedure, IPD, BREX, Applicability, DML and publishing modules. This authoring tool also includes a complete set of S1000D XML modular schema components for use with the S1000D along with other XML and SGML resources.

The Identification and Status part contains a comprehensive set of metadata elements used by the database to manage the data module. Fig. 10 shows the elements of Identification part parsed from DM. The element <dmAddressItems> contains information that is supplementary to the data module identification but not part of the unique Identifier. The element <dmCode> contains the DMC and forms the unique Identifier of a DM. The element <dmStatus> contains information about the status of the DM as shown in Fig. 11. Attributes of <dmStatus> can be 'new', 'deleted', 'changed', 'revised', and 'rinstate', The element <brexDmRef> contains a pointer to the BREX DM that applies to the data module.

To validate the documentation, we have published a technical document as shown in Fig. 12 and it explains the DM of the process to inspect the exhaust valves of main engine. The first assumption is that the worker is the first engineer who is responsible for the day-to-day management and the work level is 01. The second assumption is that the cyclic operation can be conducted in an anchored condition. The chain block is selected to retrieve that exhaust valves. Additionally, work policy and illustration information are included for the maintenance work.

3. Conclusions

This paper has discussed the ShipDex as a means of data exchanging maintenance information and lifecycle data. Data schema of DEX and procedure of ShipDex publication is also introduced. We also discuss the DEX schema represented in XML to generate technical documentation for data exchange of ship lifecycle support. The data module and the creation process are illustrated in the implemented examples. The structure of DMs and its basic principle is introduced. We show how DEX can support lifecycle data including information, DM, and document publishing using XLM.

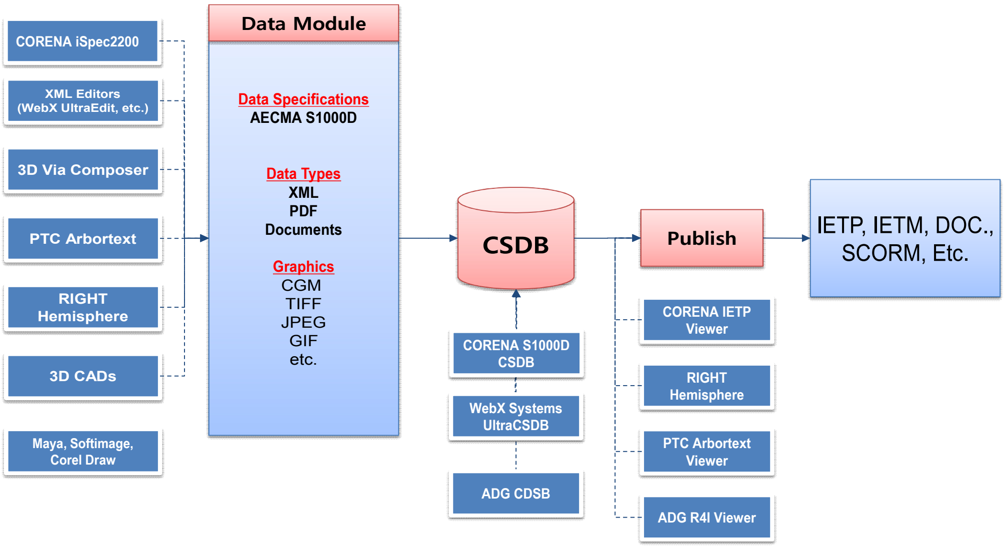


Fig. 9 Process and tools of publication for DEX document

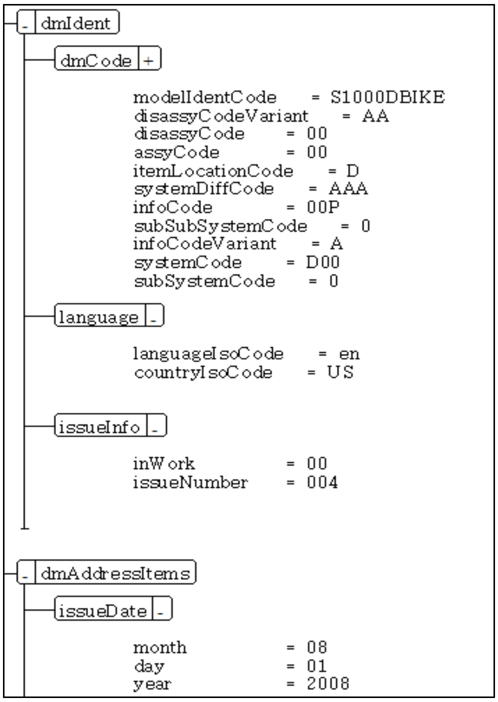


Fig. 10 Example of Identification part

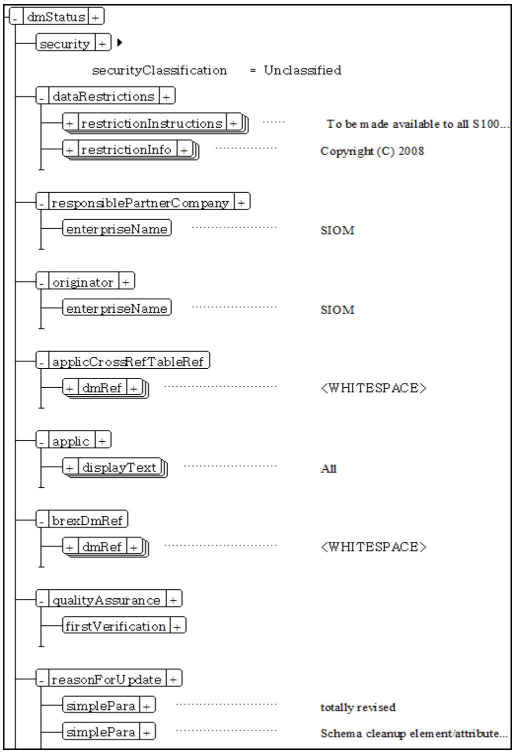
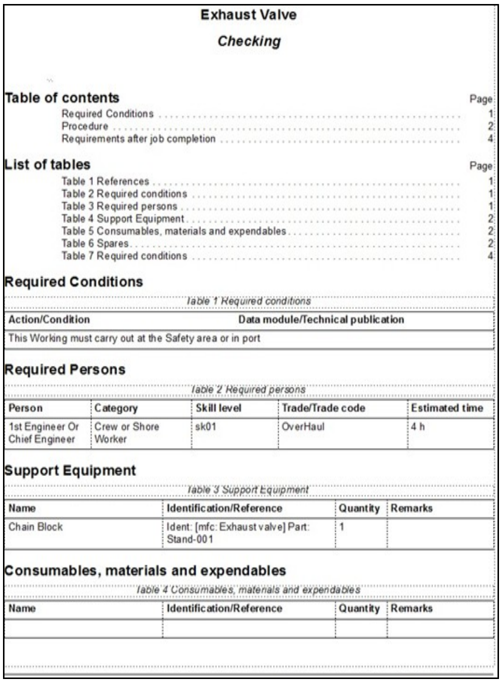


Fig. 11 Example of Status part



Exhaust Valve

Checking

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Required Conditions

Table 1 Required conditions

Action/Condition	Data module/Technical publication
This Working must carry out at the Safety area or in port	

Required Persons

Table 2 Required persons

Person	Category	Skill level	Trade/Trade code	Estimated time
1st Engineer Or Chief Engineer	Crew or Shore Worker	sk01	OverHaul	4 h

Support Equipment

Table 3 Support Equipment

Name	Identification/Reference	Quantity	Remarks
Chain Block	Ident: [mfc: Exhaust valve] Part: Stand-001	1	

Consumables, materials and expendables

Table 4 Consumables, materials and expendables

Name	Identification/Reference	Quantity	Remarks

Fig. 12 Example of publication of Procedure Data Module

References

Aerospace Industries Association of America (AIA), *A Recommendation to the Department of Defense to Adopt the S1000D – the International Specification for Technical Documentation*. (2008).

ARA, ASD & AIA, *International specification for technical publications utilizing a common source data-base. Issue 4.2* (2016).

Briggs, T L, Rando, T C, and Daggett, T A, *Reuse of ship product model data for life-cycle support*, Journal of Ship Production, 22 (4) (2006) 203-211.

Choi, Y., Park, J. H., and Jang, B, *An approach to authoring and validation of Shipdex data modules. In ICT Convergence (ICTC)*, 2013 International Conference on IEEE (2013) 889-893.

Greenough, R M, and Williams, D, *Investigating the transfer of techniques for electronic technical support documentation from aerospace to machine tools,* The International Journal of Advanced Manufacturing Technology, 32 (7-8) (2007) 774-779.

Hu, G, Wang, Y, and Bidanda, B, PLM systems for network-centric manufacturing. In IIE Annual Conference, *Proceedings of Industrial Engineering Research Conference of Industrial and Systems Engineers (IISE)* (2006, January) 1227.

Pratt, M J, *ISO 10303, the STEP standard for product data exchange, and its PLM capabilities,* International Journal of Product Lifecycle Management, 1 (1) (2005) 86-94.

Um, J, Yoon, J S, and Suh, S H, *An architecture design with data model for product recovery management systems*. Resources, conservation and recycling, 52 (10) (2008), 1175-1184.

Vatteroni, M, The SHIPDEXTM Protocol presentation, The Second Shipdex Conference, (2008).