Development of Information Datasheets of Nuclear Power Plant (NPP) Equipment using cfiXLM schema

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1. Introduction

A life cycle of a nuclear power plant (NPP) generally ranges from 40 to 60 years. During the life cycle of NPPs from conceptual design to decommissioning, huge amount of data information is generated, transferred, revised with interoperability for each stage: conceptual design phase, general design phase, equipment-detailed design phase, installation phase, construction phase, commissioning phase, operation phase, and maintenance phase[1]. For example, the design information generated during a design phase is transferred in the next phases and used for various purposes such as test, inspection and maintenance. Thus, the data information should be stored in the robust data system, managed safely, and transferred properly to be interoperable among different phases. Thus, the proper linkage among disparate data streams and the continuity among similar data streams are needed for smooth data handover. In 2009, EPRI (Electrical Power Research Institute) published a new NPP information handover guide [2] to provide NPP owners and operators with data handover templates in consistent format for effective delivery of information during all stages of the handover process.

Another difficult concern for NPP data information management is to exchange the data information among many organizations such as NPP owners, operators, engineering companies, suppliers, and vendors. As a matter of fact, the improperly formatted handover of information sometimes occurs due to the discrepancy of data format (e.g., data description language type). This improper delivery can make negative effects on NPP integrity and safety. Thus, the lack of proper exchange for different data information systems of organizations should be resolved by using an international standard data format. The standard data format can reduce the cost and time for data exchange in each phase for design, procurement, delivery, installation, operation and maintenance of equipment. The AEX(automating equipment information exchange) pilot implementation project team under EPRI advanced nuclear technology (ANT) program has been conducted a research for the use of XML equipment schemas for electronic data exchange(EDE). They applied XML equipment schema for the design, selection, quotation, purchase and mock install of a safety injection centrifugal pump using EDE standard HI(hydraulic institute) 50.7. For data exchange, FIATECH, an industry consortium, has equally developed library of templates and reference data for ISO-15926[3], which is an international standard capable of reducing data-error and delivery time for exchanging data among different organizations[4-5].

KHNP as an only owner/operator company has not experienced much difficulty in data interoperability with other organizations, but continued its unremitting exertions to develop a robust system capable of managing data information generated in all the stages of NPP life cycle. In 2003, KHNP launched development project to make standard NPP data model on the basis of international standard. The information management framework on the basis of international standard for maintenance and repair was developed by automating P&ID, 2D-P&ID translator, data management server, and browsers. KHNP also developed a methodology for data sharing between ERP system and standard NPP data model. However, the standard data model was not applied to the entire life cycle of NPP. In 2006, KHNP started another project to construct an integrated plant ontology based on GPM data model and a plant-knowledge management system to intellectualize the plant information [6-7]. A prototype for information management system on the basis of the international standard was developed in 2009. However, the use of standard data handover templates and equipment schema for EDE is still needed for successful information management. The objective of this study is to make electronic equipment datasheets for automating EDE. In this study, pilot datasheets of a control valve for demineralized water tank level were made on the basis of an international standard, cifXML(capital facilities industry XML) schema, capable of automating EDE during the design, delivery, installation, procurement, and maintenance phases.

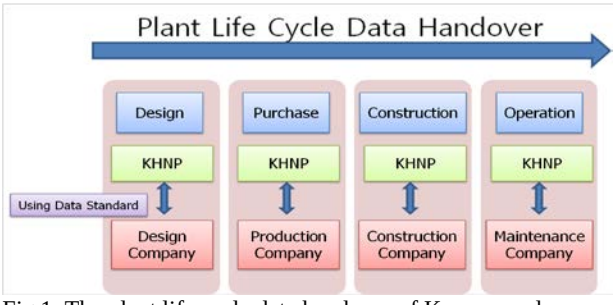

Fig.1. The plant life cycle data handover of Korean nuclear power industry

2. Data Handover Status of KHNP

KHNP as an only NPP owner company manages a lot of data information through the life cycle of NPPs ranging from design phase to operation phase. Fig. 1

shows the schematic of data handover of a NPP life cycle in nuclear power industry of Korea. In the design phase, KHNP receives electronic or printed-hardcopy design documents such as drawings, system functional descriptions, system design criteria, technical reports, design specifications and, among others from engineering companies. These design documents are used for purchasing equipment, components, and devices. During purchasing phase, KHNP receives additional equipment data for test, inspection, repair and maintenance from vendors. After completing install and construction, KHNP operates the NPP collaborating with maintenance companies. The data information in design and construction phases is managed by NPCMS(nuclear power plant construction management system) and DREAMS in operation phase[8]. These two management systems still need to be properly-linked to make effective data handover.

KHNP has maintained most data information in the data management systems in the form of PDF, DOC, HWP documentations and spreadsheet-based metadata. However, there exist several challenges for using documentations and metadata format. When a design document is revised, related documents should be changed with the revised data information. Without an automating data management system, this work results in time consuming, higher costs, and more human resources[9]. Another challenge is data information distortion due to human error which can occur when generating the data information. In the end, NPP data needs to be generated in a standard format readily available in the automating EDE system. In this study, equipment datasheets in cfiXML schema format are newly generated, which can be used in the automating EDE system.

Table I: Information for a control valve

No	Schema Type	Properties
A	site:siteFacility	information for local location of equipment
B	mtrl:materialComponentList	Valve components
C	uo:materialStream	information for liquid passing through the control valve
D	eq:controlValve	control valve information
E	eq:equipmentItem	information of equipment connected to control valve
F	customControlValveDataSheet	other need information

3. Equipment Datasheets using International Standard

The valve is widely used with its various purpose and functions in most mechanical systems of NPPs. The control valve for demineralized water makeup to WI system Comp. tank tk04 level control is selected as the initial target equipment to make datasheets in cfiXML schema format, which has been used in Shin-Kori Unit #1 and #2. The equipment data information for the control valve obtained in PDF and spreadsheet-based metadata format is used to create equipment datasheets using cfiXLM schema. Table.1 shows equipment information of the control valve for making control valve datasheets using cfiXML ControlValveDataSheet schema. The each individual information from A to F cannot be written repeatedly except uo:materialStream. The control valve data information for modification in cfiXML schema format is classified into 7 schema types as shown in Table.2.

Table II: Types of ControlValveDataSheet schema

Schema Type	KHNP information field related to schema
obj:transaction	prj_class, data_day, user, mark_no
site:siteFacility	room_no
mtrl:materialComponentList	-
uo:materialStream	-
eq:controlValve	tag_no, svc_desc, valve_type, valve_size, valve_att_code, valve_end_pre, valve_end_sch, env_zone, vdr_tag_no, qul_class, pid_no, pid_rev_no, pid_coor_no, end_end_dim, clean_class, area_dwg_no, area_dwg_rev_no, act_passv_dgnt, ps_no, ps_item_no, spec_no, rmark, pdt_no, data_sht_no,
eq:equipmentItem	line_no, ass_splool_no
customControlValveDataSheet	lvl3_nwa_no, lvl3_site_req_day, e_rtm_no, e_rtm_day, sub_sys_no, tag_sta_code, cp_no

The obj:transaction schema includes the local location of equipment information for data delivery, and is first used. The datasheets for obj:transaction, site:siteFacility, eq:equipmentItem schemas are generated with information obtained from spreadsheet-based metadata of the control valve shown in Fig.2. Fig.3 shows the example of newly-generated datasheet in obj:transaction schema format using information from control valve metadata. The datasheets for mtrl:materialComponentList, uo:matrialStream schemas are generated information obtained from PDF document data. The customControlValveDataSheet schema provides the standard of general information of control valves and the expression methods by which users can express particular information additionally. The sort of information related to construction can be expressed using this schema. The final datasheets of the control valve are

successfully created by patching each datasheet generated using cfiXLM schemas as shown in Fig.4.

No	Field	Contents	Category	Input Examples
1	tag_no	tag no	General	0-632-V-0173
2	svc_desc	service description	General	Demi WTR to CPB Comp Tk M/U CTRL v/v
3	valve_type	valve type	design spec	Globe
4	valve_size	valve size(inch)	design spec	1
5	mark_no	mark no	design spec	N/A
6	valve_att_code	valve attachment code	design spec	N/A
7	valve_end_pre	valve end preparation	design spec	Socket Weld
8	valve_end_sch	valve end schedule	design spec	80
9	env_zone	enviromental code	design spec	O
10	prj_class	project class	General	D3N
11	vdr_tag_no	vendor tag no	construction	N/A

Fig.2. Typical example of spreadsheet-based metadata of the control valve

```
<obj:transaction>
<obj:dateTime>data_day</obj:dateTime>
<obj:order>1</obj:order><ctx:person objectID="user" language="en"
xmlContent="cfiXML" objectState="fullXML" currencyCode="USD"
contentType="text/xml" unitSet="SI">
<ctx:shortID>user</ctx:shortID>
</ctx:person>
<obj:transactionType>Created</obj:transactionType>
<obj:version>13452B34</obj:version>
<obj:versionIndex>1</obj:versionIndex>
</obj:transaction>
```

Fig.3. Newly-generated datasheet in obj:transaction schema format using data information from control valve metadata

```
<?xml version="1.0" encoding="UTF-8"?>
<controlValveDataSheet objectID="eqPvfDoc.ControlValveDataSheet.AE_KHNP_21952e"
version="A3452BF4" versionIndex="1"
xmlns="http://www.cfixml.org/document/eqPvfDoc"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:etl="http://www.cfixml.org/etl" xmlns:obj="http://www.cfixml.org/obj"
xmlns:objb="http://www.cfixml.org/objb" xmlns:pq="http://www.cfixml.org/pq"
xmlns:ctx="http://www.cfixml.org/ctx" xmlns:dx="http://www.cfixml.org/dx"
xmlns:proj="http://www.cfixml.org/proj" xmlns:mtrl="http://www.cfixml.org/mtrl"
xmlns:eq="http://www.cfixml.org/eq" xmlns:site="http://www.cfixml.org/site"
xmlns:eqRot="http://www.cfixml.org/eqRot" xmlns:eqElec="http://www.cfixml.org/eqElec"
xmlns:eqPvf="http://www.cfixml.org/eqPvf" xmlns:uo="http://www.cfixml.org/uo"
xsi:schemaLocation="http://www.cfixml.org/document/eqPvfDoc ..\schema\document\eqPvf
Doc.xsd" schemaRelease="03.02.0000">

    <obj:transaction>
        <obj:dateTime>2011-10-30T11:07:56.000-00:00</obj:dateTime>
        <obj:order>1</obj:order>
        <ctx:person objectID="ctx.Person.09290010" language="en"
xmlContent="cfiXML" objectState="fullXML" currencyCode="USD"
contentType="text/xml" unitSet="SI">
            <ctx:shortID>09290010</ctx:shortID>
        </ctx:person>
        <obj:revision>A</obj:revision>
        <obj:transactionType>Created</obj:transactionType>
        <obj:version>13452B34</obj:version>
        <obj:versionIndex>1</obj:versionIndex>
    </obj:transaction>
    <site:siteFacility objectID="site.SiteFacility.Site">
        <site:siteSubArea objectID="site.SiteFacility.CPB">
            <objb:name>Compounding Building</objb:name>
            <site:customSiteSubArea>
                <objb:name>Filter and Demi valve area</objb:name>
            </site:customSiteSubArea>
        </site:siteSubArea>
    </site:siteFacility>
    <uo:materialStream objectID="uo.MaterialStream.InletDesign">
        <mtrl:materialProperty objectID="uo.MaterialProperty.InDesign">
            <mtrl:property>
                <mtrl:p basis="gauge" symbol="psi">180</mtrl:p>

    <mtrl:context><etl:propertyType>Maximum</etl:propertyType></mtrl:context>
            </mtrl:property>
        </mtrl:materialProperty>
    </uo:materialStream>
```

Fig.4. A part of the final datasheets of the control valve

5. Conclusions

In the present study, valve datasheets available for automating EDE system were developed in international standard cfiXLM schema format.

1. The data information in PDF and spreadsheet based metadata format was modified into international cfiXML schema format. It enables NPP related organizations to exchange the data information with interoperability.
2. New brand datasheet for the control valve was successfully generated by patching several datasheets obtained using several cfiXLM schemas

However, there still exists a challenge for applying the cfiXML schema to NPP industry. The data information for safety class and quality class of equipment could not be described using cfiXML schema 3.0 version. Thus the expanded cfiXML schema for use of NPP equipment needs to be developed.

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