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Construction of BIM-based SMART-ITL Facility Management System

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1. Introduction

SMART [1] is an integral type reactor. A single reactor pressure vessel contains all of the major components, which are the pressurizer, core, steam generator, reactor coolant pump, and so on.

SMART-ITL [2, 3], a large scale integral effect test facility for SMART design, is scaled down based on the volume scaling methodology and has all the fluid systems of SMART together with the break system and instruments, as shown in Fig. 1. The height of the individual components is conserved between SMART and SMART-ITL. The flow area and volume are scaled down to 1/49. The ratio of the hydraulic diameter is 1/7. Therefore, SMART-ITL is a large-scale thermal-hydraulic test facility with about 45 m height, which is consisted of 10 m underground and 35 m from the ground level.

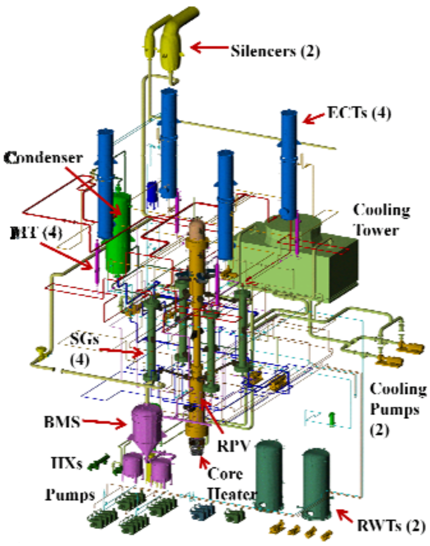

Fig. 1 Schematics of the SMART-ITL

Until now, the management of design data and maintenance of large scale test facilities have been managed based on hard-copy information.

Recently, Thermal Hydraulics Safety Research Division (THSRD) at Korea Atomic Energy Research Institute (KAERI) has developed Facility Management System (FMS) based Building Information Modeling (BIM) to manage its design data more effectively for these large scale test facilities of SMART-ITL and ATLAS, and this BIM technology has been applied to SMART-ITL at the first.

BIM is a process involving the management of information linked with the data of geometrical shapes and functional characteristics of buildings. This enables to store and utilize complicated and diverse data, which are produced during the whole life cycle of various physical infrastructures.

BIM extends the building design from two-dimensional to three-dimensional technical drawing in order to maximize the efficiency of design, construction and maintenance. It manages and utilizes comprehensively all sorts of data, which can be used for the managements of planning, construction and operation.

This study proposed a method of effective management and maintenance of design data applied to the SMART-ITL. That is, a FMS was developed based on the BIM technology for SMART-ITL. Figure 2 shows an overview of FMS development process based on BIM technology.

Fig. 2 FMS development Process based on BIM technology using Digital Space Framework 3.0

2. SMART ITL FMS

2.1 3D Visualization of SMART-ITL

SMART-ITL FMS simulates all the geometrical data of composing elements of SMART-ITL such as building, structure, components and instruments through 3-dimensional (3D) modeling, and visualizes it in the virtual space. Figure 2 shows 3D modeling and visualization of SMART-ITL.

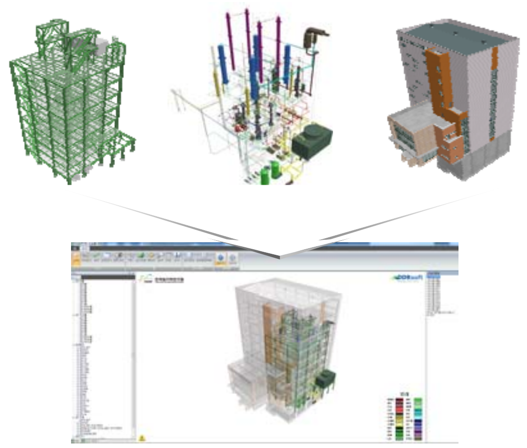

Fig. 2 3D Modeling and Visualization of SMART-ITL

Shape information, which is drawn by various demands and different methods, is stored in an integrated database, and then it is visualized by 3D viewer of SMART-ITL FMS.

The shape information was classified into building, structure, instruments, and pipes. Building and structure were categorized by each floor and classification of instruments and pipes followed the way of Bill of Material (BOM).

This classification system is visualized as a form of tree on the left of screen and Hide & Show function key allows it to display specific shape information by user's demand.

User can comprehend the test facility more intuitively through 3D viewer and it enables user to recognize spatial position of components and to access them easily.

3D viewer categorizes and displays the shape information of building, structure, instruments and pipes by the form of tree, so it facilitates efficient space utilization when needed to install additional components or to change design and layout. Figure 3 is an example of visualized 3D viewer through SMART-ITL FMS.

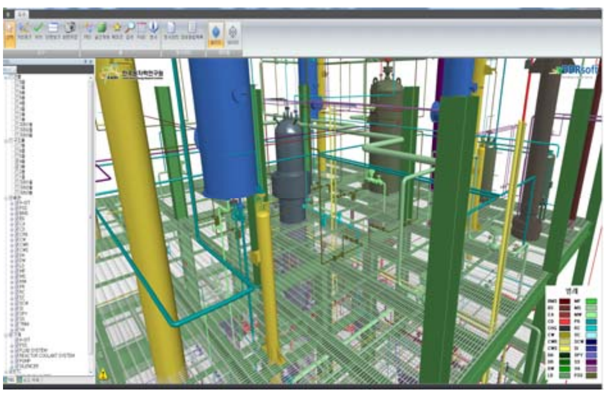

Fig. 3 3D Viewer on SMART-ITL FMS

2.2 Data Management System

Design data of components, which compromise SMART-ITL, is stored into and operated in an integrated database of FMS. The stored design data is formed to be able to link 3D shape information, and the user can access the design data such as drawing, technical specifications, piping and instrument drawing (P&ID) in real time. Also, the user can confirm instantly 3D shape of instruments, which are delineated on P&ID, by using link function between P&ID and 3D shape information.

In addition, FMS has data upload system in order to update information immediately when a change of design occurs. User can keep design data up to date by managing the revision history of design data, which is stored in an integrated database. Figure 4 shows an example of P&ID link function of SMART-ITL FMS.

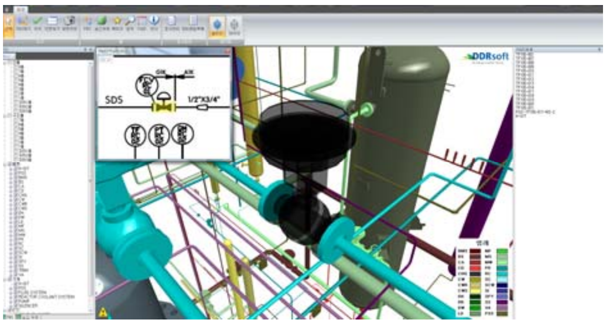

Fig. 4 P&ID Link Function of SMART-ITL FMS

2.3 Instrument Maintenance System

Instrumentation management system was built in SMART-ITL FMS for effective management and maintenance of instrumentation, which is one of crucial elements in various thermal-hydraulic test loops.

User can maintain and manage instrumentations comprehensively by compiling a comprehensive list of equipment list of main instruments such as the pressure transmitter, thermocouple and flow meter, and by recording the instrumentation history including specifications and calibration of instrumentations.

A comprehensive list of equipment is linked to 3D shape information, so the user can recognize intuitively the location of instruments by just one clicking. Data of instruments such as its detailed technical specification and calibration report is stored into design information database and it facilitates the user to read and revise data of instruments.

For the instruments whose calibration is necessary, the user can set up calibration period and calibration alarm function to perceive which instruments should be calibrated during the next calibration period.

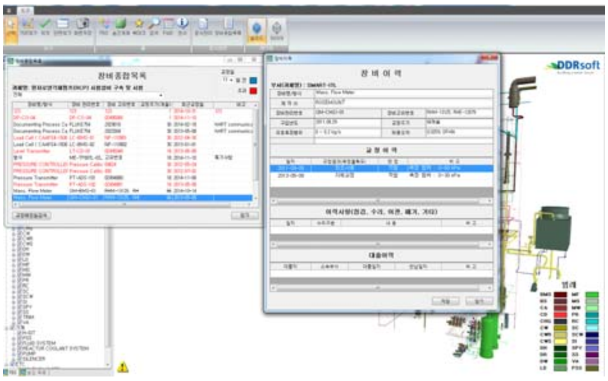

Fig. 5 Instrument Maintenance System of SMART-ITL FMS

3. Conclusions

SMART-ITL FMS facilitates its management and maintenance more effectively and accurately by 3-dimensional visualization. It enables the shape information of large scale test facilities to be visualized intuitively in a virtual space, and the efficient maintenance of data and instruments is possible by linking 3D shape information. In addition the user facilitates the building integrated database including the shape and design information to be uploaded and revised conveniently, and the up-to-date data can always be kept.

SMART-ITL FMS is scheduled to be upgraded after few years in order to correspond to Quality Assurance Program (NQA-1/ISO9001), which is operated by THSRD at KAERI. Also, there is a plan to improve instrument monitoring system. It is expected that 3D viewer enables us to monitor the real-time variations of various thermal-hydraulic parameters of pressure and temperature, etc., in selected locations.

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