IMPLEMENTATION INFORMATION TECHNOLOGY IN THE NUCLEAR POWER PLANT (NPP) CONSTRUCTION

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Abstract: Nuclear Power Plant (NPP) Construction is a long-term project with huge scales of construction data and it requires a large number of materials, labor and equipment. Also it is a grand scale project that invested with billions to build a major power supply system. To effective manage NPP construction project, it is essential to cooperate with each entities such as owner, contractor, subcontractor and regulatory agency, etc. Therefore, it is necessary to implement an information system that can be improved productivity through collaboration among construction companies and business processes in the NPP construction. By implementing information technology during project (distribution and management, pursuing integration and interfacing information with other contractors), each stage has been developed segmental information technologies. Implementing a total project management system in NPP is a key element in this paper. Therefore, the purpose of this paper is introducing an integrated information technology system for NPP. Actual examples will be given from the Uljin Nuclear Power Project.

Keywords: Nuclear Power Plant, Project Management, Information Technology

1 INTRODUCTION

Nuclear power plants (NPP) generate about 40% of electrical energy in Korea. It is a very high value compare with other countries because Korea does not have heat sources such as oil, gas, and falling water. That is the reason that Korea does concern NPP to produce electricity. Recently, 16th NPP is operating and other six NPPs are on construction in Korea. A NPP construction is a great scale project that has about 5 billion dollars construction costs and also 120 months construction schedule. Good project controls not only include planning, scheduling, estimating and cost control but also coordination of information and services. By implementing information technology during project (distribution and management, pursuing integration and interfacing information with other contractors), each stage has been developed segmental information technologies since 1990's. Thus, NPP has made a great success with developing and adjusting unit system such as designing, scheduling, cost, material, data management system by each construction level. However, due to the lack of information sharing system with other fields like business, finance and material, there was a limitation to optimize the whole corporate.

According to developing information technology, domestic NPP especially Uljin 5&6 has been tried combining between project management process and information technology. Implementing a total project management system in NPP is a key element in this paper. Therefore, the purpose of this paper is introducing an integrated information technology system for NPP especially Uljin 5&6 for actual case.

2. NUCLEAR POWER PLANT

2.1 Characteristics on the Project Management View Point

Nuclear Power Plant (NPP) Construction is a long-term project and requires huge scales of construction data, materials, labor, and equipment. Also it is a grand scale project invested with billions to build a major power supply system. To manage NPP construction project effectively, it is essential to cooperate with each entities such as owner, contractor, subcontractor and regulatory agencies, etc. It is also important issues for establishing and operating the system that can be explained by communication with various construction companies, standard regulations, and procedures such as corresponding letters, project identification systems and project management procedures.

To assist these operations in assessing the overall status of the plant, well organized project management is necessity. Thus, the view point of project management, it can be described into five characteristics in NPP. 1) long-term mega project usually 10 years from general planning, 2) generates enormous quantities of data such as quality documents, drawings and data so on, 3) great distance between data producer and user, 4) information that delivered and shared in a short time, and 5) sensibility environmental changes at organization and cooperative work system.

2.2 Project Management System

It is common that for the effective construction project, procedures and management system are kept

according to business characteristic after considering site characteristics, design, contract, and construction method. However, for the NPP construction, which requires accumulate improvement in productivity and experience in construction systematically, standardized business management systems is needed. It can be divided into organization, procedure, information, and identification system. <Table 1>

Table 1. Project Management System

System	Contents
Project related Entities	- Design, Procurement, Construction Unit (Head office and site) - Owner, A/E, Equipment supplier, Construction contractor
Project Management Procedure	- Project Procedures and Manual (PPM), Procedure manual for construction progress, Construction cost, Material, Data - Site Internal Procedure manual (SIP), Operation and quality procedure
Information System	- Server, OS, Network, Database, Application program - System design document, User manual
Project Identification System (PIS)	- Physical classification of building and system: PBS - Functional classification of plan/ data and type of construction: FBS

2.3 Work Breakdown Structure

To manage the complexity of NPP, structure breakdown is one of the most important works. The structure that various works cohered organically and segmented is called WBS, and this classifies all the construction works into top-down hierarchy.
It is segmented and systemized up to the level that planning and control management can be carried effectively. WBS can be applied identification of work and definition, defining responsibilities for work achievement, identification of minimum working unit, integration of cost and scheduling management, and so on. <Table 2>

2.4 Project Identification System

This system also greatly assisted integration, not only of documents, but also engineering and subsequent procurement, construction, and startup activities. NPP utilize a system that combined a physical breakdown structure (PBS) with an organizational breakdown structure (OBS) and a functional breakdown structure (FBS). The result is a basic number that could identify any drawing, component, cost account, schedule activity, or other product with its appropriate location or system. The common identification system became a common language.

Table 2. Nuclear Power Plant Construction WBS

Level 1	Level 2	Level 3	Level 4	Level 5	Process Rate(%) Cost[C]	Weighted Process Rate		Items
SKN1,2					%, C			Shin-Gori1,2
	C				%, C	100%		Capital Cost
		PRE			%	2%		Project Preparation
		ENG			%, C	8%		Design
		PRO			%, C	27%		Purchasing
			NSSS		%, C		10%	Installation of Reactor
			TG		%, C		4%	Turbine Generator
			BOP	A,C,..	%, C		13%	Auxiliary Equipment
		CON			%, C	58%		Construction
			CP	A1,C1,..	%, C		54%	Main Installation
			CX		%, C			Separate Order
			CY		%, C		4%	Collateral Installation
		STU			%, C	5%		Commissioning
		SUP			C			Labor Cost
		OWN			C			Owner's Cost
	F				C			Fuel

3. INTEGRATED INFORMATION SYSTEM FOR NPP

3.1 The Necessity of Integrated Information System

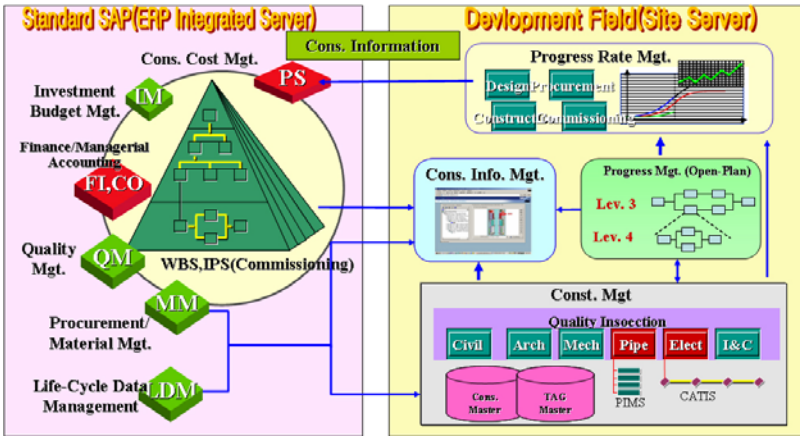

Figure 1. Construction Integrated System Implementation Plan

With the objective of simplifying the complex network of computing devices employed within NPP, modern technology and integration techniques are being used to form centralized databases and distributed processing and display networks.
Benefits are immediate as a result of the integration and the use of standards. The use of a unique data acquisition and database subsystem optimizes the high costs of engineering, as this task is done only once for the life span of the system. This also contributes towards a uniform user interface and allows for efficient expansion and maintenance. This paper features an information system as configured in Figure 1.

To establish a comprehensive project control program, controlling costs is very important method. Identifying the scope, quantifying the amount of work, and accurately monitoring progress are elements of a good method. Project control is not a set of stand-alone elements. NPP construction requires sophisticated project control systems to complete on schedule and within budget. Furthermore it needs integrated cost and scheduling systems and integration between each project entity for effective project control. Therefore, the development of this control system enabled NPP to fully use the network system that deals with designed drawings, engineering data, and supplier that supplies materials and machineries. To deliver huge information for business management, implementation of information delivery system should be preceded such as method for providing data, procedures, and network formation. (Refer to Figure 2)

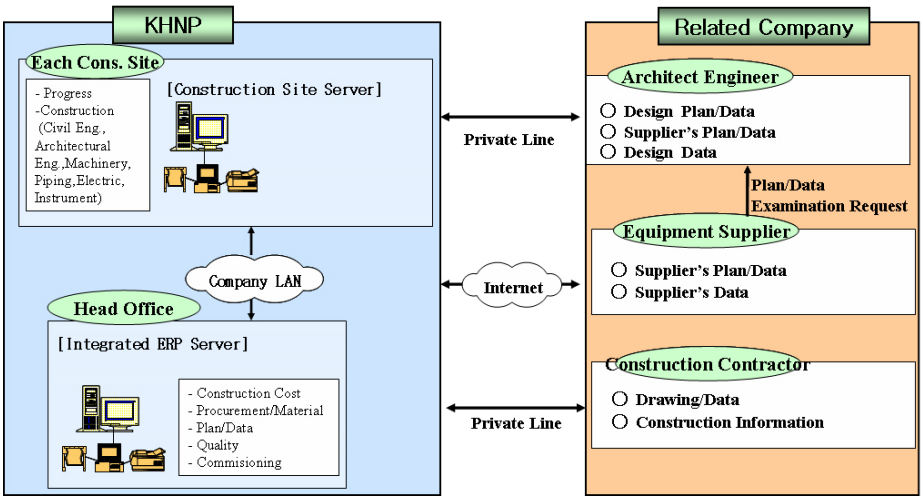

Figure 2. Network Structure

The network helps communication among A/E, contractor, and owner (stakeholder). Basically NPP manages a lot of data, drawings, bills, and specifications. Those design model information and image information are extracted with Engineering Database (EDB) and provided to owner. The network can quickly identify not only individual drawings and tagged equipment for each construction activity but also the status of each activity.

4. BENEFITS OF AN INTEGRATED INFORMATION TECHNOLOGY

The expected benefits of an integrated information system in a nuclear power plant construction are as follows;

- Make the most out of the existing signal wiring (network data), and have the capability to access every piece of information from every IT console (PC, PDA etc.).
- Improve both resolution and response time, with the evolution of hardware (workstations, persona computers, local area networks, etc)
- Improve communication through the construction information sharing and exchanging
- Integrated business process reduces duplicate work and it improve work productivities
- Accuracy and simple data can be used by standardization of recording form and procedures
- Historical data for re-used in further project

According to integrated information system for NPP, every management revision requires analysis, validation, and qualification of the process. This process takes into account the original design requirements.

After an analysis of the impact of the change in plant management, a team of engineers must compile all the documentation into a single document. Then detailing all the changes and its engineering documents are assembled. Therefore, those are

evaluated and approved by leaders who involved each area (civil, mechanical, and so on) easily. Basically those responsible for the affected documents are reflected the as-built state of plant.

Korea Hydro Nuclear Power (KHNP) has been analyzed about 700 forms from around 200 procedures and level of 'paperlessization' by using the integrated information and a network system. The fields were Civil & Architecture Engineering, Machineries, Electricity, Instrumentation, and Piping. The result shown in Table 3, each stage reduced 30.2% in the paperless. The concept of 'paperless' is not only to reduce the overhead cost but also to deliver information to the parts of each stage on a real time basis and to improve the efficiency of control management.

<Table 3> Electronic Approval System Result

Fields	Items to be Analyzed	Level of 'Paperlessization'		
		Electric Approval*	Images**	Work by hand
Civil Engineering	267	87	121	59
Machineries	302	29	258	15
Electricity	62	41	16	5
Measurement/communication	40	24	8	8
Pipelines	32	32	-	-
Total	703	213	403	87

*Electric Approval: As data that has items to be managed, its level of importance is high and needed to be shared with other fields
**Images: Low level of importance, not too valuable as data

NPP construction must break down to the lowest level work stages. It includes unique work number, installed volume, information on locations and references. Table 4 shows a sample of inspecting stages. Each stage report helps grasp the point of progress in upper level of scheduling.
This effort included developing or assisting in the development and maintenance of the project identification system, the material index and material tracking system, the construction activity packaging system, and other project documents.
The material tracking system monitors equipment from the initial engineering stage through procurement, warehousing, construction, and into startup testing.
The integrated project schedule is a primary management tool. This reference document identifies contract commitments between each entity. The document contains a detailed CPM schedule for engineering, construction and startup.

5. CASE STUDY

5.1 Uljin 5 and 6

Piping information technology system which was applied during construction of UlJin 5&6 was carried out with the goal of 'paperlessization of whole piping processes.

<Table 4> Inspecting Stages by Work Type

Fields	Types of Work	Inspection Stages	Achieved Level	Report
Construction	Steel Frame Work	Preparation		Inspection Report On Steel Frame
		Building steel frame	60%	
		Filling Grout in base plate		
		Measurement		
		Bonding of Bolt	90%	
		Bonding of Weld		
		Coating	100%	
	Coating	Checking of work condition		Inspection Report On Coating
		Checking of used materials	30%	
		Mix		
		Coating	90%	
		Drying coating	100%	
		Elimination of pollutes		
		Test of adhesive force		
	Installation of Measurement Instrument	Welding of strut (Manufacturing)		

The development of the system was completed in July, 1999 and the system was applied in the plant site in September, when piping construction began.
This construction of piping is a work of installing pipe such as welding pipe and designing pipe and in the system, the function that deals with process work such as inspection plan, notification, review of document, etc. and the function that prints any kind of reports for statistical analysis, using history data. 32 cases of construction procedures were reviewed, 22 cases were complemented and 32 kinds of inspection recording sheet were standardizes and approved electronically.
For information sharing, network system was formed with contractors at the job site so that any drawings and construction information can be used in real time.

5.2 Utilization of the System

September 1999, the pipeling construction began. End of March 2004, the performance of utilization of the system is quite satisfied. At that time it has been about 100% of construction completed, and also about 400,000 of work master has been implemented among the construction.
For the preceding projects, a construction supervisor from construction companies dealt with about 330,000 documents related to installation of pipe by hand, referring to design drawings and construction

data. A construction supervisor made reports of inspection plans or notifications as hard copy so that a supervisor had to go through 3-4 stages to get them approved. Also, notification and input of results from inspection are managed consistently by this system. Results from inspection are printed in the form of reports or kept in the Lifecycle Data Management (LDM) separately to manage them electronically.

5.3 Assessment of the System

Although the system was implemented and utilized for piping field among all the construction fields in constructing UlJin 5&6, the system focused in establishment of construction information management system, standardization of work processes, and collaboration of companies. Other related works have been affected by this system. There have been improved in many areas after using the system (Figure 3). 1) Drawings are delivered electronically and printed out at the plant site. It took more than a week to use hard copy drawings before. 2) Inspection plan and approval work took about 4-5 days but it is shortened to 1-2 days.

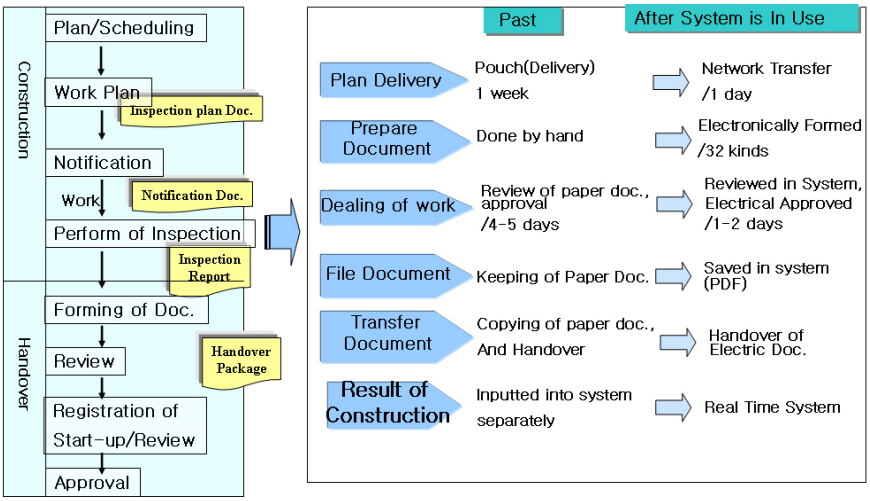

Figure 3. Assessment of System

3) All the drawing procedures are saved in the server as electronic files so that anyone related to construction can look for data in real-time, which shortened the time and papers spent on work processes. 4) It is possible to calculate the rate of construction process so that requiring work volumes and materials can be estimated by using history data. 5) In the line of assuring the quality, by managing the history of inspection with the name of the person who was in charge of the inspection such as worker, inspector and quality manager, the system helps to use electronic name system. 6) Information sharing system between owners and contractors improved the transparency of work. This case can be regarded as a successful example, which proved the possibility of rapid and accurate work management.

6. CONCULSION

Information technology in each designing, scheduling, cost, material, and data management has been segmental operating in the previous NPP projects. Uljin 5&6 implemented integration and interfacing information technology system for pursuing better control the project. In other words, project management using information technology affect the majority of the project cost. Using integrated information system in a NPP is gathering following conclusions;

- NPP construction should be managed thoroughly from the planning stage. Various construction-related organization as well as individual should now be able to utilize information system for better communication and collaboration.
- The concept of 'paperless' is not only to reduce the overhead cost but also to deliver information to the etities of the organization (internal & external) on a real time basis, or as close to real time as possible.
- The conventional practice of a three-week look ahead or 6-month-rolling schedule is no longer efficient. When something occurs that influences or affects the schedule, it should be updated to project schedule in real-time.

There can be proved a great result if this information system in NPP construction is applied to privatized construction business such as building apartments or public work of large scale like constructing high-speed railroads.

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