

Development of Information Technology in the Construction and Maintenance of Nuclear Power Plants

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OVERVIEW: Hitachi is currently implementing a business process reorganization based on the introduction of an enterprise resource planning (ERP) package, a Web-based work scheme, and knowledge management, in order to increase the efficiency of the construction and maintenance of nuclear power plants and implement further improvements in reliability and technological knowledge. We also intend to provide support for the more efficient operation of power companies and will contribute to ensuring the stable operation and competitiveness of nuclear power generation by enhancements of construction and maintenance work by 3D CAD and technical information links over the Internet.

INTRODUCTION

NUCLEAR power generation is becoming a key source of energy in Japan, accounting for approximately 35% of our total power generation capacity. Since high levels of stability and reliability are required with nuclear power generation, reliability assurance is important throughout all business activities from the licensing stage through the design, construction, inspection, and operating stages. Against the current background of the liberalization of power production, a major concern that has arisen is the need to reduce the management load of power companies and it is also becoming increasingly important to increase the efficiencies of plant design, operation, and maintenance work even more than before. Information technology (IT) has a role to play in solving these problems.

This article discusses the enhancement of construction and maintenance work by the application of IT to nuclear plants, which are required to have a high level of reliability and which are also equipment-intensive (see Fig. 1).

TECHNICAL POSITION OF ENTERPRISE PROCESS REORGANIZATION

Hitachi is actively promoting enterprise process reorganization and the introduction of IT, with the objective of improving business efficiency in nuclear power generation and increase the reliability of plants.

Our basic approach is in three parts: (1) integration of the key businesses of manufacturers and the centralization of data, centered on an enterprise

resource planning (ERP) package, (2) strengthening of business links by intranet/extranet (Web), and (3) using knowledge management to maintain and improve technical prowess relating to nuclear power plants (see Fig. 2). We consider it important to use these means to maximize our value to the power companies who are our customers.

A nuclear power plant is a comprehensive construction project formed from a large number of operations, including the design, supply, manufacture, and installation of up to several hundred individual items of machinery, piping, valves, electrical devices, measuring equipment, and components. Rapid and accurate monitoring of the capital necessary for construction and project statuses relating to processes and quality, as well as investigation of optimal processes, are important concerns when ensuring that each project is completed efficiently and with a high level of quality. That is why Hitachi has introduced ERP as a center for the integration of databases.

There are also mutual relationships between the large number of tasks involved in plant construction, which makes it extremely important to ensure seamless linkages between the various enterprise processes and between different organizations, in order to improve quality. That is why Hitachi is actively promoting the use of a Web that also covers links with the power companies who are our customers. This enables plant operation and maintenance work by various methods, such as defining work flow by Web screens which is enabled by a shift from focusing on conventional database systems to focusing on enterprise processes.

Fig. 1— Use of IT for Information Cooperation with Power Companies. A fusion of Web technology with Hitachi's experience and techniques relating to plant data, construction, and maintenance will enable close technical links with power companies. It will also implement efficient plant construction, improve operating reliability, and increase maintenance efficiency.

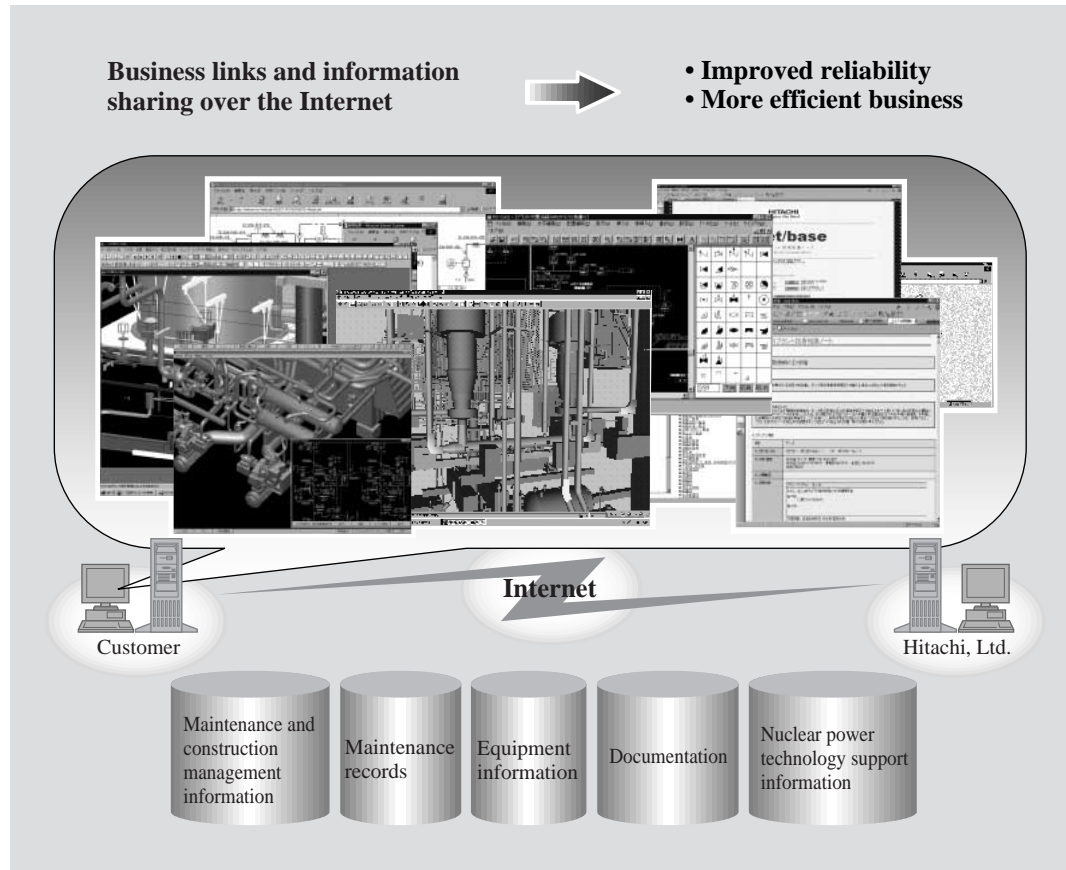
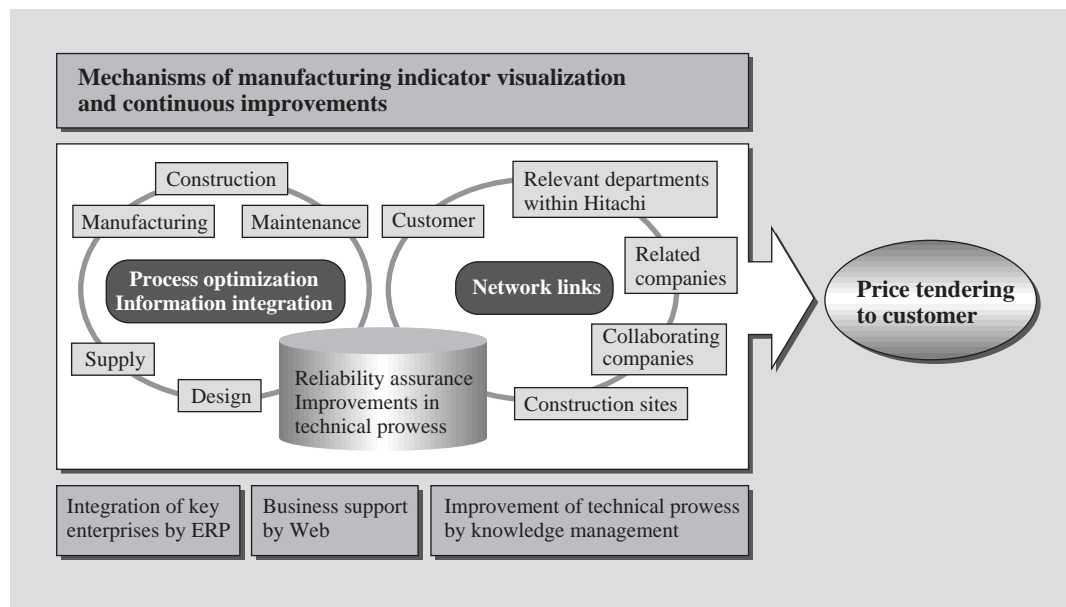


Fig. 2— Hitachi's Basic Approach to Enterprise Process Reorganization. Basic IT is intended to integrate organizations and businesses and also provide continuous improvements in manufacturing capability by visual indicators.



In addition, since it is essential to ensure reliability over a long period of time from the start of operation of each nuclear power plant, it is important to maintain and improve the related technology over the years. From that viewpoint, we are promoting knowledge management for document control, technical

experience, and knowhow transmission and usage. We consider that these activities will enable us to implement work fusion between the various manufacturing-related organizations and will also implement quality assurance over the entire life-cycle of each plant.

PLANT DESIGN ENHANCEMENT

To improve the plant design field, we are developing and applying our own “Integrated Construction System.” This is a construction support system based on design and schedule information that has been converted into electronic form. It features visualizations of the design schedule and current project management functions that are linked to it (see Fig. 3). Details of this system are given below.

- (1) Implementation of early draft designs of detailed installation construction plans, using the various simulation functions of plant design 3D CAD and the “Just In Time” system for the flow of materials
- (2) Enhancement of indirect tasks by converting management information of construction sites into electronic form and implementing precise work drafts

More specifically, we first define the installation areas that control the construction plans, using plant design 3D CAD. This information is linked to design data within the CAD system, to create data for controlling the construction. The installation work is planned for each individual area, checked by making use of the various simulation functions of this CAD package, and the results are stored in a work schedule database. This 3D CAD package is also linked to other systems such as intelligent P & ID (piping and instrumentation diagrams) CAD and is also used in

construction planning such as details of pressure test and cleaning. By enabling the exchange of data with architectural manufacturers, we can supply the results of investigations of construction and electrical installation to related personnel as animations, bringing the construction plans to life.

Scheduling and design data is also sent to construction sites, for use as electronic information throughout the entire on-site work such as schedule management, work instructions, and in-person inspections.

ENHANCEMENT OF PREVENTATIVE MAINTENANCE

From the viewpoint of a stabilized power supply from a nuclear power plant, even small faults must be avoided. Taking the piping that is a vital part of the structure of a nuclear power plant as an example, various checks and inspections are done during periodic inspections, based on the degree of importance for preventing incidents before they happen. These include checks on welds, thicknesses, and pipe support apparatus, and repair or replacement is also done if traces of deterioration are found. An older nuclear power plant that has been operating for over thirty years will have generated a huge volume of records of these checks, inspections, repairs, and

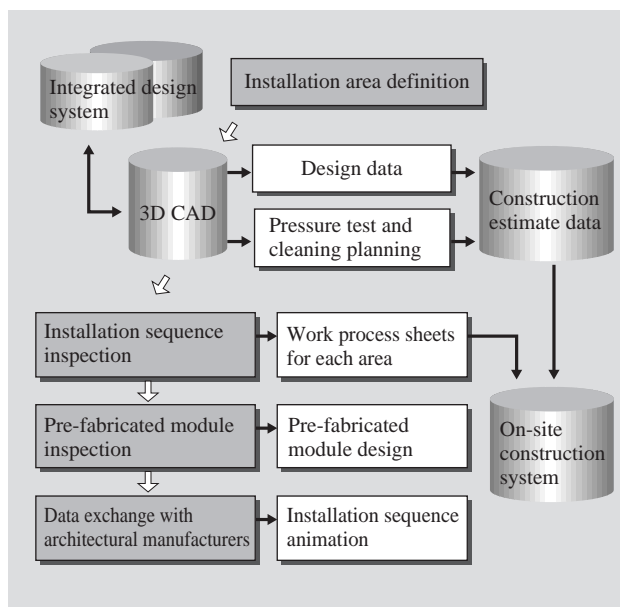


Fig. 3— Configuration of Hitachi's Integrated Construction System.

This system provides visualizations of construction plans and enables higher efficiencies in on-site construction work, based on 3D CAD data.

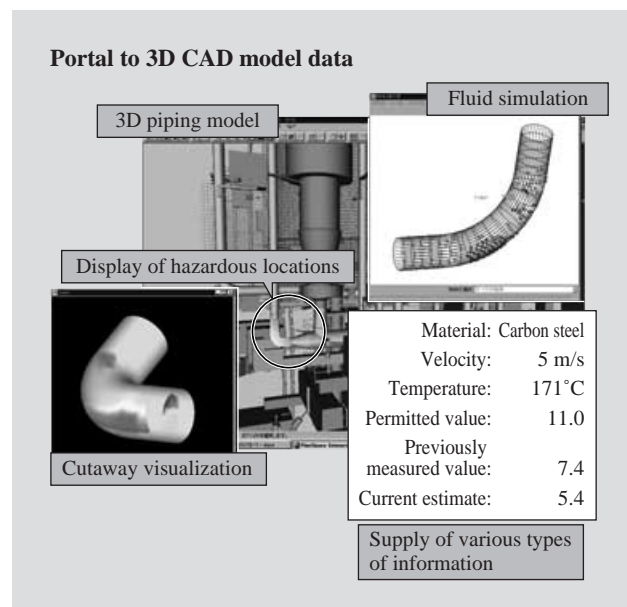


Fig. 4— Example of Access from CAD Data to Information.

The results of checks enable referencing of predicted hazardous parts and information on those parts, status visualization, and simulations.

replacements.

That is why Hitachi is promoting the construction of a maintenance support system that enables easy access to various types of information, using the plant design 3D CAD system as a portal. This system integrates all the recorded information and enables decisions on appropriate checks and replacement plans, and is designed to improve the preventative maintenance work for nuclear power plants.

Since this maintenance support system enables easy access to any number of checks and repair/replacement histories, as well as design information on similar parts, it becomes possible to speed up inspection and replacement plan drafts and increase the reliability of maintenance plans. This also enables plant data analysis and simulations of life-time predictions and the display of hazardous parts, which makes it possible to achieve a further enhancement of preventative maintenance plans by the discovery of various latent and actual needs relating to preventative maintenance (see Fig. 4).

ENHANCEMENT OF RELIABILITY IMPROVEMENT ACTIVITIES

As operating plants are upgraded and become older, the quality assurance of plants is becoming more and more of an important concern.

Even since Hitachi adopted ISO 9001 in 1998, we have used a customer-orientated quality assurance

system within that framework. To ensure that this quality assurance system operates reliably, the application of IT is now required. Basically, we consider it important to create resources from design documentation and data, and thus construct a reliable foundation that can develop horizontally and reflect our accumulation of technical experience on various situations such as faults. We also consider it important to improve meta-design skills [improve our quality control (QC) system] as a setup that enables the visualization of linked activities.

Individually, the following systems and groups of systems are considered:

- (1) Document management system to facilitate access to existing knowledge (documents)
- (2) System for managing the design of new products
- (3) Design review management system
- (4) Systems for ensuring quality at the design stage, such as a design change management system
- (5) Reliability evaluation tools such as fault tree analysis (FTA) and fishbone (element analysis) methods
- (6) Technical knowledge systems that ensure that past fault occurrences, knowhow, and technical knowledge are reflected accurately in products

Hitachi intends to develop products of even higher quality by using Web technology to integrate these systems (see Fig. 5).

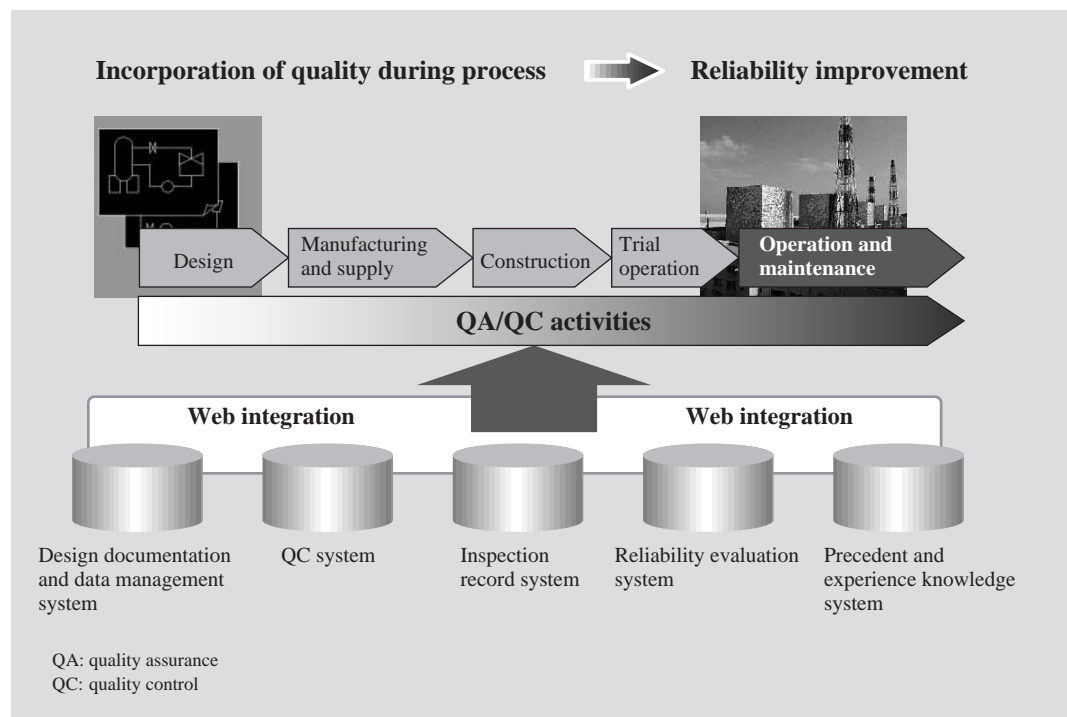


Fig. 5— Plant Reliability Assurance by IT. This enables overall reliability assurance and state visualization, by combining all the reliability-related systems on the Web.

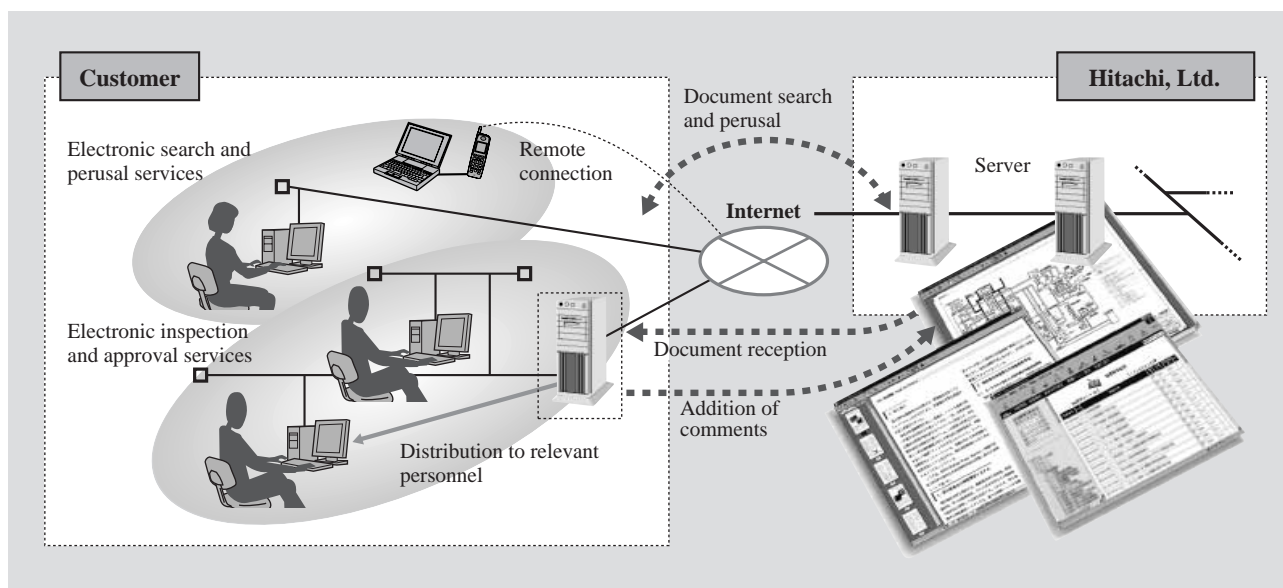


Fig. 6— Technology Information Services on the Internet.

This shows the layout of electronic document search and perusal services and electronic inspection and approval services using the Internet. Information on the Internet can be protected from leakage to outsiders by user verification technology and encryption.

TECHNICAL INFORMATION LINKING VIA THE INTERNET

The Internet has created an era of instantaneous information transfer around the world. Various types of plant information can also be made common and exchanged through the Internet. This is making it possible to use technical documents relating to plant design development and plant remodelling in real-time, and also easily implement life-cycle management of plant information from plant design through operation, maintenance, and preventative maintenance.

Hitachi operates an electronic library database system called E-net that responds to inter-company business. We plan to make full use of the results of operating this system to support customers by providing various information services such as document search and delivery over the Internet, as well as inspection and approval work. Technology information services create a virtual system that enables search and perusal functions of documents relating to plant construction projects ordered by customers, and provides electronic support for document inspection (comment processing) and approval over the Internet. This will make it possible to make technical comments common, enabling projects to proceed smoothly. Such electronic processing will make it possible to greatly reduce the lead time relating to technical information links, by

improving the efficiency of customer inspection work and incidental work and also by liberalizing information management (see Fig. 6).

Note that since E-net can be installed on our customers' own sites, customers will be able to implement various different technology information links with manufacturers.

CONCLUSIONS

This article discussed the application of IT to the construction, preventative maintenance, and reliability assurance activities of nuclear power plants, together with the trend in using IT to create and support technical information links over the Internet.

There are now approximately fifty plants in operation and they are also aging, so there is a strong demand for even higher levels of reliability in the nuclear power plants that play such a key role in energy supply. For that reason, Hitachi proposes the use of IT to implement Web-based business links and cooperation, in order to improve business efficiency and reliability from a comprehensive viewpoint. We intend to implement this by transmitting and improving our technical prowess in nuclear power plants and reliability assurance and also by setting up links with customers who are responsible for their operation and the plant manufacturers who supply plant facilities.

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