# Hitachi's Involvement in Nuclear Power Plant Construction in Japan

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*OVERVIEW: To protect the global environment and achieve a sustainable society, the Hitachi Group established a long-term plan called "Environmental Vision 2025" whereby its products will contribute to an annual reduction of 100 million tons of $CO_2$ emissions in fiscal 2025 compared with 2005. Hitachi-GE Nuclear Energy, Ltd. is helping fulfill this vision by making a significant contribution to reductions in $CO_2$ emissions through its extensive role in the manufacture of nuclear power plants. The company is currently working on ABWRs for two new nuclear power plants in Japan, Unit No. 3 at the Shimane Nuclear Power Station of The Chugoku Electric Power Co., Inc. and the Ohma Nuclear Power Plant of Electric Power Development Co., Ltd. Based on Hitachi's considerable experience and track record, these plants are being constructed to the highest global standards for safety and reliability. Construction of these nuclear power plants uses construction methods such as modular construction along with various construction support and construction management technologies to ensure that the work remains on schedule and is spread smoothly, and that more advanced preventive maintenance, manufacturing and logistics management practices are adopted.*

## INTRODUCTION

FOUR ABWRs (advanced boiling water reactors) are already in operation at nuclear power plants in Japan with two more currently under construction.

Hitachi was responsible for the construction of all six of these reactors. The entire Hitachi Group comes together in the construction of new nuclear power plants, and in addition to optimizing and

*Fig. 1— Construction of Unit No. 3 at the Shimane Nuclear Power Station of The Chugoku Electric Power Co., Inc.*
*The plant is being constructed using the latest construction methods including the large crawler crane at the right of the photograph. Equipment installation is now in progress with building and equipment construction proceeding in parallel.*

standardizing the ABWR design, work is progressing on more advanced construction technologies based on the group's considerable experience in construction.

This article discusses the characteristics of Hitachi's construction technologies for nuclear power plants and the latest management technologies for plant construction.

## CHARACTERISTICS OF CONSTRUCTION TECHNOLOGIES FOR NUCLEAR POWER PLANTS

### Construction Processes

Construction of Unit No. 3 at the Shimane Nuclear Power Station of The Chugoku Electric Power Co., Inc. (1,373 MW ABWR) (Shimane No. 3) began in December 2005 with the obtaining of the initial construction plan approval and Hitachi is working hard to have the plant ready to start commercial operation in December 2011 (see Fig. 1).

At the Ohma Nuclear Power Plant of Electric Power Development Co., Ltd. (1,383 MW ABWR) (Ohma), construction started with the obtaining of the initial construction plan approval in May 2008 and is currently at the stage of excavating the building foundations. Ohma is scheduled to start commercial operation in November 2014.

### Construction Methods and Applied Technologies

Construction at Shimane No. 3 and Ohma uses improved construction techniques based around the concept of large-block modular construction which Hitachi has used in previous plants. Construction support technologies that utilize the latest information technologies such as three-dimensional CAD (computer-aided design) systems and RFID (radio-frequency identification) are also used to improve safety and reliability, keep construction on schedule, and ensure that construction work is spread smoothly.

Specifically, the following construction methods are used: (1) optimization of modular construction and use of composite module, (2) utilization of a large crawler crane, (3) parallel construction and open-top method, and (4) floor-packaging construction method.

Applied technologies are discussed below.

(1) Optimization of modular construction and use of composite module

Modular construction is a way of reducing on-site work and improving work efficiency. Equipment, pipes, valves, platform, and other items that are to be separately installed are assembled beforehand at the factory or in the site yard and then carried in by large cranes for installation.

As one of the first companies in the world to adopt this practice, Hitachi has been using this method at nuclear power plants since the early 1980s and has independently developed its own technology. For this design approach, a CAE (computer-aided engineering) system with functions specifically intended for module design, such as support for the generation of assembly drawings and an automated lifting point calculation, is used to integrate the engineering processes from design through to production and site delivery. Hitachi can also utilize a dedicated factory for module production that was completed in 2000. Construction at Shimane No. 3 will use about 190 modules and about 100 modules are to be used at Ohma.

One of the modules being manufactured by Hitachi is the module for the inside of the RCCV (reinforced concrete containment vessel) which includes valves, pipes, large support structures, and the reactor shield wall to be placed in the upper dry well. This module has a total weight of about 650 t. Expanding the range of applications where modules can be used in this way improves the efficiency of on-site work (see Fig. 2).

For Shimane No. 3, two HCU (hydraulic control unit) room modules (with the total mass of about 270 t per module) were also manufactured at the factory and then delivered to the site (see Fig. 3).

*Fig. 2—RCCV Interior Module (Upper Dry Well).*
*The on-site assembly of an RCCV (reinforced concrete containment vessel) interior module is shown. The total mass is approximately 650 t.*

These modules are designed to improve quality and minimize on-site work. In cooperation with Kajima Corporation, Hitachi modularized the entire rooms by incorporating the ceiling, floor, walls, and other building structures into the module together with the equipment to be installed in the rooms.

Hitachi's aim with these near-complete integrated modules is to optimize the process of modular construction.

(2) Utilization of a large crawler crane

A large crane plays a key role in Hitachi's construction techniques. The large crawler crane (lifting capacity: 930 t) was introduced in 1984 and is used to lower large equipment and modules directly into position at the site. This has expanded the scope for using modular construction.

Shimane No. 3 uses a large crawler crane to unload goods directly from ships. Because the Shimane No. 3 construction yard is located next to a wharf, the area between the wharf and buildings where the equipment is to be delivered is set aside for the use of the large crawler crane to allow goods to be unloaded directly from the wharf.

This increases the efficiency of unloading work and allows greater use of modules even if their weight exceeds the capacity of the permanent cranes installed at the wharf (see Fig. 4).

(3) Expansion of parallel construction and open-top method

To ensure the delivery and installation of the huge number of components required in the construction of a nuclear power plant, Hitachi uses concurrent construction methods called parallel construction to deliver and install equipment while building construction is still in progress.

Not only has the range of the components installed in advance at Shimane No. 3 and Ohma been expanded, efficiency is also being improved by bringing work forward or optimizing work procedures by, for example, carrying out work such installing operating pulpits or performing basic setup for equipment, panels, and racks while construction of the building is still in progress.

Because the climate in Ohma is extremely cold, construction of the steel framing will be brought forward to improve work efficiency in winter. This involves erecting the permanent steel frame to the height of the roof before installation of the floors and walls so that a removable temporary roof can be placed on top to keep out the rain and snow. The advantage is that it allows work to continue without being affected by the weather. Combined with the modular construction technique described above, this all-weather work environment helps further improve efficiency and provides an optimum method for construction work in a cold climate (see Fig. 5).

(4) Floor packaging construction

Normal practice has been to conduct system pressure tests on piping work after construction work is completed up to the top floor of the building. As a result, many pipe pressure tests are conducted in the final phase of construction work, and this is followed by scaffold dismantling and other incidental work such as thermal insulation, painting, and filling, creating a large peak in the workload. To avoid this, Hitachi has adopted a practice of performing independent pressure tests whereby it identifies those systems located on underground floors or on which


*Fig. 3—HCU Room Module.*
*The entire HCU (hydraulic control unit) room module at the dedicated module factory prior to shipment is shown.*

*Fig. 4—Direct Unloading by Large Crawler Crane.*
*The large crawler crane unloading (lifting) the upper body module of the condenser is shown.*

it is relatively easy to conduct separate independent pressure tests for each floor of the building. The aim is to spread the workload more evenly by bringing work forward and optimizing work procedures.

## LATEST CONSTRUCTION MANAGEMENT TECHNOLOGIES FOR NUCLEAR PLANTS

### Development of Integrated On-site Construction System for Nuclear Plants

A nuclear plant consists of a huge number of components. Examples include the approximately 30,000 on-site pipe welding points (with a total length of piping of about 150 km) and a total cabling length of about 2,000 km. Highly advanced design and construction management technologies are required to install all of these components efficiently and accurately.

To take advantage of IT (information technology) in the management of plant construction, Hitachi has developed an integrated on-site construction system for nuclear plants to ensure that work planning is carried out reliably and that associated work is done efficiently. The system has been used at actual construction sites.

The integrated on-site construction system is structured in a way that allows the planning, execution, measurement, and corrective steps of the project management cycle to be performed, and has links to three-dimensional CAD and other design data to cover everything from the installation work plans for the equipment, pipes, cables, panels, racks, and other components used in nuclear power plants to work instructions and on-site inspections, and from pressure testing plans through to the handover plans leading up to trial operation.

*Fig. 5—Image of RCCV Lower Liner being Lowered into Position in Steel Frame.*
*The image shows the lower liner being lowered into the steel frame which has already been constructed and from which the temporary roof has been removed.*

### Advanced Construction Management Using RFID

At Shimane No. 3, Hitachi has developed and is getting ready to implement construction management methodologies and associated systems for using mobile PCs (personal computers) and RFID for warehousing and delivery management, installation work record management, and cable connection work to improve the efficiency with which this information is entered into the system and to improve reliability by preventing data from being entered incorrectly.

Hitachi is also building an integrated system from factory production through to on-site installation and preventive maintenance that uses RFID in applications such as preventive maintenance and production management at the factory (see Fig. 6).

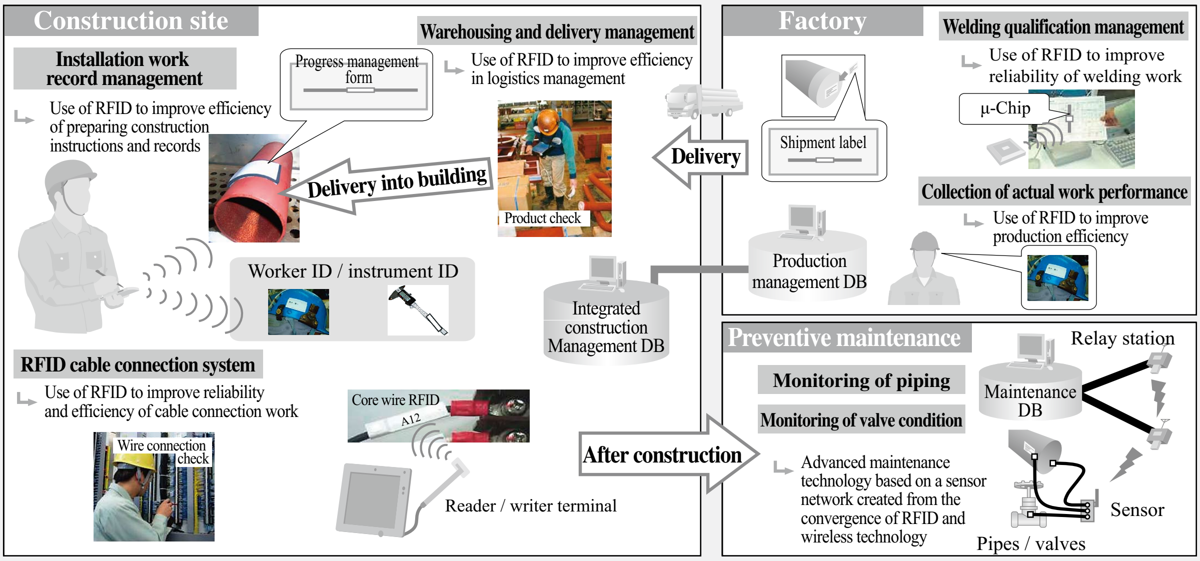
RFID is a technology for automatically identifying objects or people via radio using a dedicated reader, and that works by attaching an IC (integrated circuit) tag (generally called an electronic tag) to the object being identified. The IC tags have a built-in chip that contains data identifying the object or person and allows contactless authentication. By attaching IC tags to workers' hard hats or products, large quantities of inward goods can be processed instantaneously and accurately, for example (see Fig. 7).

Currently, RFIDs are used in warehousing and delivery management for products such as pipes, valves and supports. In the area of installation work record management, the technology is in the process of being put to use in applications such as matching piping installation records with workers and measuring instruments. The range of applications is expected to broaden and become more sophisticated in the future.

## CONCLUSIONS

This article has discussed the characteristics of Hitachi's construction technologies for nuclear power plants and the construction management techniques being used for the most recent of such plants.

The Hitachi Group is putting its full effort into the construction of Unit No. 3 at the Shimane Nuclear Power Station of The Chugoku Electric Power Co., Inc. and the Ohma Nuclear Power Plant of Electric Power Development Co., Ltd.




RFID: radio-frequency identification ID: identification DB: database

*Fig. 6—RFID System for Nuclear Power Plants.*
*An integrated RFID system is under development that covers every phase from the factory through to the construction site and preventive maintenance.*

As an all-round manufacturer of nuclear power equipment, Hitachi-GE Nuclear Energy, Ltd. will play a central role in the Hitachi Group to achieve the construction of safer and more reliable nuclear power plants, taking advantage of its considerable past experience.

Hitachi also intends to make further improvements in reliability by introducing next-generation technologies such as RFID to the management of power plant construction.


*Fig. 7—Use of RFID with Products and Materials.*
*RFID is used for product identification and data input at dispatch and delivery.*

## REFERENCES

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