HCU Room Module Supplied to The Chugoku Electric Power Co., Inc. Shimane Nuclear Power Plant Unit No. 3

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OVERVIEW: Hitachi-GE Nuclear Energy, Ltd. has developed and improved construction technology for advanced boiling water reactors based on extensive experience in boiling water reactor construction. Shimane Nuclear Power Station Unit No. 3, which is being supplied to The Chugoku Electric Power Co., Inc., is now under construction using HGNE's latest construction technology. In particular, HGNE applies a "room module" for HCUs. This room module is composed of building structures such as walls, the ceiling, floor, and almost all mechanical components inside the room such as piping, platform, and cable trays. Once the room module is installed at a site, the work is almost completed. Therefore, the amount of work at a site can be significantly reduced, which helps to distribute the work evenly. HGNE collaborates with Kajima Corporation to design and assemble the HCU room modules.

INTRODUCTION

NUCLEAR power plant construction has required a high level of safety for society and reliability at a low cost to meet the recent trend to cut back on investment in the power industry. Hitachi-GE Nuclear Energy, Ltd. (HGNE) has applied modularization since the 1980's to address the need. This aims at improving work safety and quality, and lowering cost by prefabricating products, such as piping, valves, and equipment originally installed at a construction site, in shops and carrying them to the site all at once by using large crawler cranes. HGNE introduced the modularization method using tower cranes in 1980 (described as the first generation in the chronology below) and established the use of large modularized components by using large crawler cranes (capacity of 930 t-m) in the second generation. In the third generation, a module dedicated shop was built and started operation in

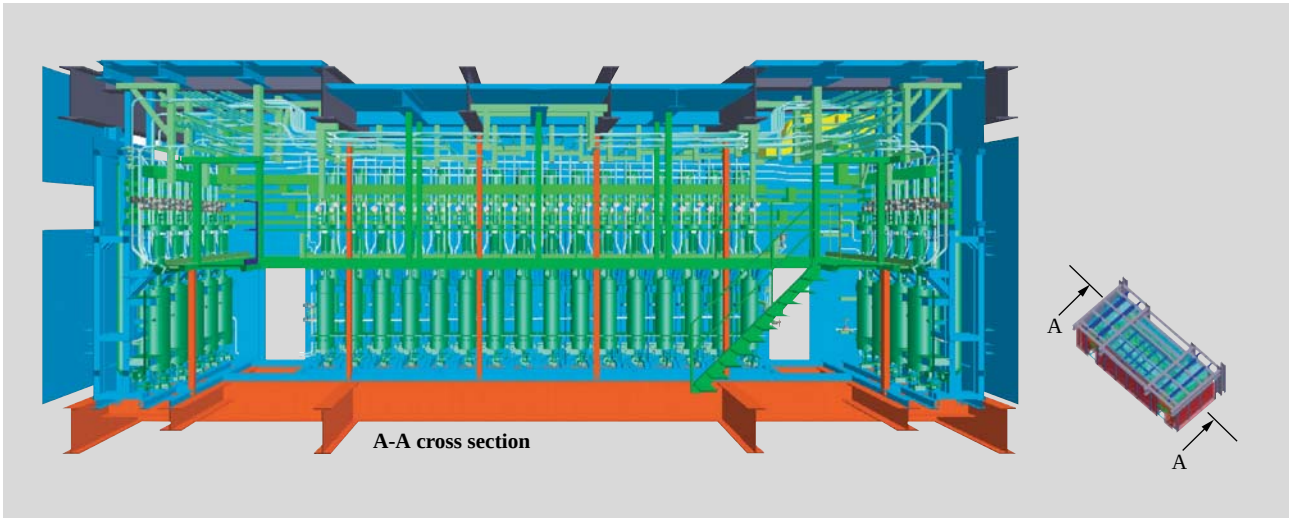

Fig. 1—HCU (hydraulic control unit) Room Module Cross Section.
All parts (excluding cables and instruments) were modularized.

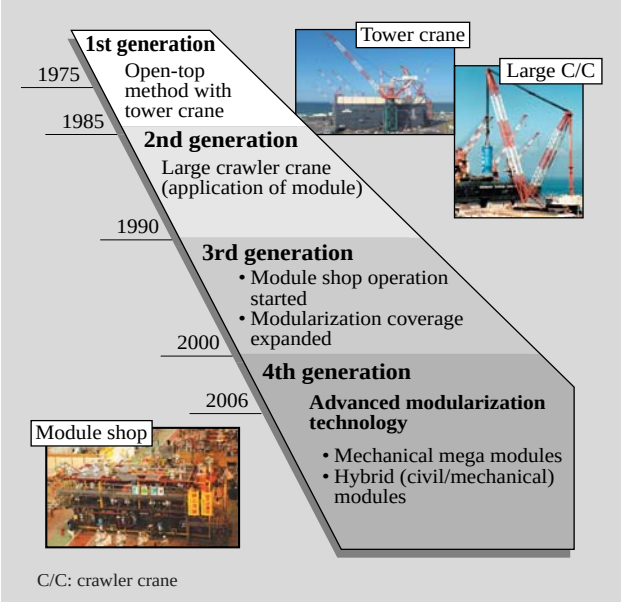

Fig. 2—History of Modularization.
Modularization introduced using tower cranes in the late 1970's, and the highest level of quality is being pursued in the fourth generation.

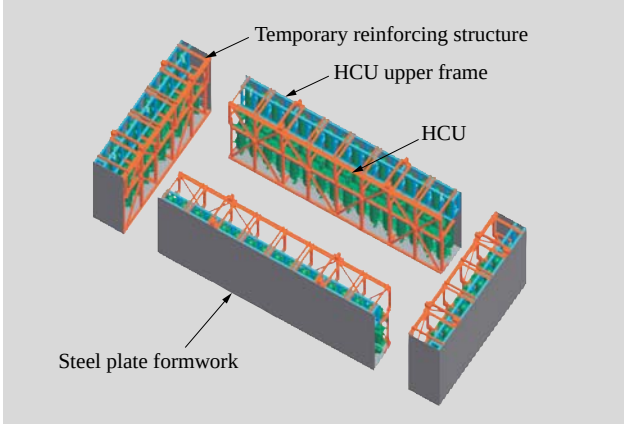

Fig. 3—Structure of Conventional HCU Module.
Modules are composed of united structure of wall members and HCU because HCUs are arranged along the inside walls. Modules are divided by walls and temporary reinforcement is provided to enhance their stiffness upon shipping.

September 2000, which increased the number of modules and expanded its application coverage significantly. In addition to quantitative expansion, in the fourth generation, HGNE is deeply committed to qualitative improvement to reach the highest level of quality. In modularization, a "high-level" module always enables the minimization of remaining work at a site, and room module is the final form. As its name suggests, room modules consist of products prefabricated and assembled like a room. Building structures such as walls, the ceiling, floor, and all mechanical components are included inside the room such as piping, platform, and cable trays (excluding cables and instruments) (see Figs. 1 and 2). The room module was applied to an HCU (hydraulic control unit) for constructing the Shinane Nuclear Power Station Unit No. 3 (Shimane-3), which is being supplied to The Chugoku Electric Power Co., Inc. To apply an HCU room module, we need to cooperate with building construction companies, which are in charge of the building design and construction work at a site. HGNE has collaborated with Kajima Corporation in development, design, and fabrication while pursuing both companies' benefits (minimization of remaining work at site). The following describes the summary and features of these room modules.

HCU ROOM MODULE IN THE PREVIOUS PROJECT

HCU modules were arranged along the inside walls for the purpose of making space available for maintenance in the latest type of reactor, the ABWR (advanced boiling water reactor). HCUs were bolted with foundation bolts recessed into the wall, so the wall components with the bolts and HCU needed to be combined before being carried onto the site. HCU modules in previous projects were divided into four walls (see Fig. 3). These modules were aimed at reducing the workload; however, they required a large quantity of temporary materials (such as reinforced members for ensuring stiffness during transportation and carrying onto sites) and resulted in not contributing to lowering the workload at a site. In addition, there was a concern about maintaining their quality. Although some sheet curing was provided to prevent moisture from modules, precision machinery, there was still a possibility of rust causd by dew condensation.

Therefore, HGNE decided to apply the room modules, which modularize all HCU rooms, to solve the problems described above and transfer a huge amount of work performed at sites to the shops.

OUTLINE OF HCU ROOM MODULE

Building Structure

An HCU room module is a super structure with a gross weight of 270 t. Concrete is not filled in the

framework during shipping, discharge or carrying in by cranes, so extra reinforced members must be placed in the modules to increase the load weight. Spaces for the extra reinforced members are needed to minimize changes made in the arrangement within the HCU room at this time. Arrangement in the HCU room was almost determined, and it required a huge amount of time and energy for design modification. Therefore, the reinforced members were placed inside the room to minimize the number of changes. However, placing them was difficult because they obstructed reinforcing bars inside the walls in the ordinary RC (reinforced concrete) structure. To resolve this problem, HGNE decided to change the structure to SC (steel plate reinforced concrete), which makes more space available inside the wall.

Mechanical Components inside HCU Room Module

Steel skids were placed on the floor as the reinforced members for modules described above. That enables shortening the inside height of module rooms in comparison to those of the previous plants. And HGNE adjusted the arrangement of the products within the HCU room and achieved a more compact design. Almost all the products listed below were prefabricated except electric cables, which cannot be handled in the HCU room.

(1) HCU
(2) Process piping and support
(3) HVAC (heating, ventilation, and air conditioning) duct and support
(4) Cable tray and support
(5) Electric cable piping and switch box
(6) Chain block monorail for maintenance of HCU
(7) Temporary materials for site work (such as lights and dehumidifiers)

Equipment and air pressure tests required by law were conducted on the HCU in the presence of witnesses from The Chugoku Electric Power Co., Inc. and Japan Nuclear Energy Safety Organization (JNES) before assembling the modules. Necessary tests of process piping were also conducted at the shop in the presence of JNES's witnesses.

HCUs, which are precision machines, need to be waterproof and controlled for humidity. All piping, cable, and HVAC duct openings were closed with iron board or caulked to keep out water. Dehumidifiers were placed in the room module for moisture control.

Work tasks listed below were provided on site for this module. Only connecting work remained inside and outside of the room module:

(1) Carrying in and setting HCU room module
(2) Placing wall and ceiling concrete (by building construction companies)
(3) Connecting piping, HVAC, and cable trays outside of room module
(4) Laying cables inside and outside of HCU room

ASSEMBLING HCU ROOM MODULE

HCU room modules have been constructed since August 2006 in the module shop owned by HGNE, and one has been constructed for shipment in February 2008 (see Fig. 4). The modularization work started with SC wall assembly by Kajima Corporation. The HCU was installed in March 2007 (see Fig. 5). Process piping was assembled in May 2007 (see Figs. 6 and 7). After the assembly was completed, the module was

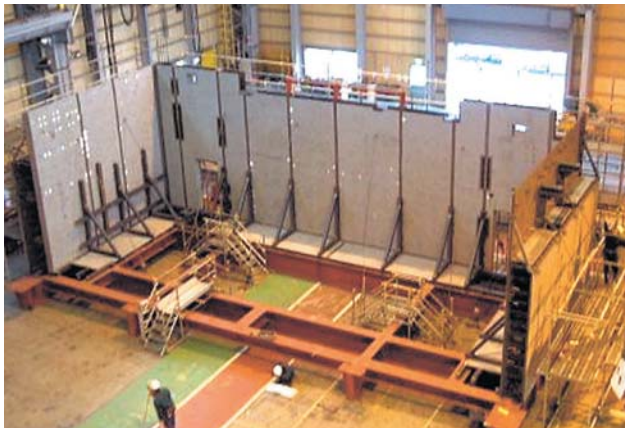

Fig. 4—HCU Module Assembly (1).
SC (steel plate reinforced concrete) wall installation was performed by Kajima and Hitachi (January 2007).

Fig. 5—HCU Module Assembly (2).
HCUs were installed and anchor bolts were embedded on SC walls (March 2007).

Fig. 6—HCU Module Assembly (3); Process Piping Welding. Process piping was welded and installed after HCU installation. This room module was shipped after all piping in the room was installed (May 2005).

Fig. 7—HCU Module Assembly (4); Process Piping Installation. Installation of piping and support for the piping was completed (October 2007).

carried to an adjacent seaport using a special carrier device called a multi-roller whose structure is based on a hydraulic jack, loaded onto the ship by the dock crane, and transported to the Shimane-3 site by ship.

INSTALLATION OF HCU ROOM MODULE

The HCU room module was shipped and carried into the Shimane-3 site safely in February 2008. A crawler crane owned by Hitachi Transport System, Ltd. was used for the unloading and carrying in procedure. This enables us to omit the secondary transportation from the seaport. No major problems emerged during the carrying in procedure.

Fig. 8—HCU Module Assembly (5). Panoramic view of HCU room module is shown. This is the final phase before shipping (January 2008).

Fig. 9—HCU Module Installation. HCU was carried in by crawler crane at Shimane-3 site (February 2008).

CONCLUSIONS

HGNE applied a modulated HCU room for constructing Shimane-3, which is being supplied to The Chugoku Electric Power Co., Inc. Almost all of the fabrication in the HCU room such as walls and ceiling was modularized, and it contributed to lowering the workload at the construction site substantially. In domestic Japanese market and abroad, demand for new nuclear power plants has been increasing. We intend to contribute clean and safe power supplies by constructing highly safe and reliable nuclear power plants based on our modularization technology.

AKNOWLEDGMENTS

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