TOSHIBA REVIEW

2010 VOL.65 NO.12

Special Reports

Continuously Growing Nuclear Business

Expectations for Globalization of Japanese Nuclear Industry
HATTORI Takuya

On the Occasion of Special Reports on Nuclear Energy
IGARASHI Yasuharu

Expansion of Nuclear Businesses of Toshiba Group
OKAMURA Kiyoshi

Forefront of Nuclear Power Plant Technology Development
IIKURA Takahiko / KITSUKAWA Keisuke

Nuclear power plants, which contribute to reliable energy supplies, incorporate a large number of technologies. As a leading nuclear company, Toshiba is promoting nuclear businesses in various fields including the construction of new light water reactors (LWRs), maintenance services for operating LWRs, nuclear fuel cycles, fast breeder reactors, nuclear fusion, and accelerators.

We have a strong sense of responsibility to lead the sustainable development of nuclear technologies based on our experience in construction and maintenance, plant design and analysis, system engineering and equipment technologies, instrumentation and control systems, and materials science and chemistry.

Construction of Overseas Nuclear Power Plants for First Time by Japanese Industry
MARUYAMA Tohru / NARUSE Yoshihiro / YABUTA Hitoshi

In response to the worldwide demand for stable energy supplies and the reduction of greenhouse gas emissions, nuclear power plant construction projects have been expanding on a global scale. Even in the United States, where no nuclear power plants have been constructed over the past 30 years, there are plans for the construction of more than 30 plants. Toshiba has been awarded a contract for a nuclear power plant construction project in the U.S., the first case of overseas nuclear power plant construction by Japanese industry.

Toshiba America Nuclear Energy Corporation (TANE), the first U.S. subsidiary in our nuclear business, located in Charlotte, North Carolina, is engaged in this globally prominent project, applying various technologies and know-how that we have cultivated over many years of experience in developing and constructing nuclear power plants in Japan and adapting them to U.S. business practices, laws, and regulations.

Domestic and Overseas Development of Advanced Boiling Water Reactors
HATAZAWA Mamoru / FUCHINO Satoshi / NAKADA Kotaro

Since Toshiba delivered the world's first advanced boiling water reactor (ABWR) to The Tokyo Electric Power Company, Inc. in 1996, we have been devoting continuous efforts to the construction and operational support of ABWR systems as major products. We are now promoting the construction of domestic and overseas ABWR systems along with the standardization of ABWRs. We are also engaged in the research and development of core technologies to support further promotion of ABWRs as a concurrent solution to the issues of global warming and energy security for individual countries.

Global Deployment of AP1000$_{TM}$ Third-Generation-Plus Nuclear Power Plant
NODA Tetsuya / HATAZAWA Mamoru / OKUBO Osamu

Westinghouse Electric Company (WEC) is promoting expanded global deployment of the AP1000$_{TM}$ pressurized water reactor (PWR), which is the only third-generation-plus nuclear power plant to have received design certification from the United States Nuclear Regulatory Commission (NRC). Based on the proven performance of WEC-designed PWRs, the AP1000$_{TM}$ not only achieves a significant reduction in the amount of equipment required compared with conventional PWR systems by making use of passive safety-related systems, but also makes it possible to reduce construction costs and shorten the construction period by means of advanced construction technologies such as modular construction techniques, steel-plate-reinforced concrete (SC) structures, and so on.

In China, four AP1000$_{TM}$ plants—two in Sanmen and two in Haiyang—are under construction on schedule. In the United States as well, the preconstruction of two out of six contracted plants is currently underway at the Vogtle site in Georgia and the V.C. Summer site in South Carolina. WEC is accelerating proposal activities in response to the increase in nuclear power plant construction plans in many countries throughout the world.

Development of Next-Generation Light Water Reactor
ISHIBASHI Fumihiko / YASUOKA Makoto

The Next-Generation Light Water Reactor Development Program, a national project in Japan, was inaugurated in April 2008. The primary objective of this program is to meet the need for the replacement of existing nuclear power plants in Japan after 2030. With the aim of setting a global standard design, the reactor to be developed offers greatly improved safety, reliability, and economic efficiency through several innovative technologies, including a reactor core system with uranium enrichment of 5 to 10%, a seismic isolation system, long-life materials, advanced water chemistry, innovative construction techniques, optimized passive and active safety systems, innovative digital technologies, and so on. In the first three years, a plant design concept with these innovative features is to be established and the effectiveness of the program will be reevaluated. The major part of the program will be completed in 2015.

Toshiba is actively engaged in both design studies and technology development as a founding member of this program.

Improvement of Capacity Factor of Operating Nuclear Power Plants
TANAKA Kazuhiko / TAKAYAMA Takuji / SHIMIZU Shunichi

The capacity factor is the key factor indicating the performance of an operating nuclear power plant. To increase economic efficiency while reducing carbon dioxide emissions, a strong need exists worldwide for improvement of the capacity factor of nuclear power plants. The average capacity factor in Japan is approximately 70%, as compared to more than 90% in other countries. This difference is due to longer operating cycles and longer duration of maintenance in Japan, despite a decline in the number of unscheduled outages in recent years reflecting the abundant accumulation of experience and introduction of new technologies in this field.

To rectify this situation, Toshiba has embarked on the Smart Nuclear Plant Plan, a new project aimed at achieving a capacity factor of 95% or more, and has been developing and introducing the relevant technologies.

Performance Enhancement and Life Extension Technologies for Nuclear Power Plants
OKUBO Osamu / ASANO Naoki / YABU Tomohiko

About half of the nuclear power plants in Japan have been operating for more than 30 years. There is consequently an increased need for improvements in reliability and profitability as well as lifetime extension of existing nuclear power plants as a countermeasure against global warming.

As a solution to these issues, Toshiba has developed the following technologies for existing nuclear power plants: (1) a performance-enhancing technology for steam turbines to prevent degradation due to aging, (2) various laser-based maintenance and repair technologies for inside reactor vessels, and (3) technologies to enhance power supply systems by reconstructing the entire system and renewing aging facilities.

Latest Technologies for Monitoring, Instrumentation and Control Systems of Nuclear Power Plants
MAEKAWA Tatsuyuki / TOTSUKA Shinichi / NAKAKUKI Isao

The main control panel of a nuclear power plant is designed based on human factors engineering (HFE), considering the physical size, field of view, and cognitive characteristics of plant operators. In particular, main control panels for nuclear power plants in the United States must conform with the regulatory requirements of the Nuclear Regulatory Commission (NRC) in addition to their HFE design. Toshiba has developed an HFE evaluation facility that makes it possible to evaluate human factors by changing display colors and symbols, control response times, and so on under the same conditions as in an actual main control panel, and installed it in Japan and the U.S.

Furthermore, the instrumentation and control systems of nuclear power plants are required to offer not only high reliability, but also improved economic efficiency of operation including long-term supply of maintenance parts, reduction of maintenance costs, and so on. To meet these requirements, we have developed a nuclear reactor instrumentation and control system using field-programmable gate arrays (FPGAs) and completed the product lineup.

Approach to Securing of Stable Nuclear Fuel Supplies
KOIKE Kunihisa / IMAMURA Isao / NODA Tetsuya

With the dual objectives of not only ensuring stable electric power supplies but also preventing global warming, the construction of new nuclear power plants is being planned in many countries throughout the world.

Toshiba and Westinghouse Electric Company (WEC), a member of the Toshiba Group, are capable of supplying both boiling water reactor (BWR) and pressurized water reactor (PWR) plants to satisfy a broad range of customer requirements.

Furthermore, to meet the growing demand for the securing of nuclear fuel supplies, Toshiba and WEC have been promoting the strengthening and further expansion of supply chains in the fields of uranium production, uranium hexafluoride (UF_6) conversion, uranium enrichment, and fuel fabrication.

Activities Related to Establishment of Nuclear Fuel Cycle
SHIBANO Takayuki / NARUSE Katsuhiko / ICHIKAWA Nagayoshi

As a total nuclear power plant supplier, Toshiba has designed and constructed many of the major components of the Rokkasho Reprocessing Plant of Japan Nuclear Fuel Ltd., Japan's first commercial reprocessing plant, for the establishment of a nuclear fuel cycle in Japan. To reduce the load on the global environment, we are now engaged in the design and development of new facilities for the plant, including a waste treatment facility and a storage facility. We are also promoting the research and development of advanced reprocessing technology to realize the next-generation nuclear fuel cycle, in order to secure a stable energy supply in the future.

Decommissioning Technologies for Nuclear Power Plants
TANAKA Kazuhiko / SHIBANO Takayuki / NARUSE Katsuhiko

Commercial operation of a number of nuclear power plants in Japan has ended, and the decommissioning of these plants, including dismantling of facilities, decontamination of radioactivity, treatment of radioactive waste, and so on, has commenced. In response to these circumstances, Toshiba has developed various decommissioning technologies for nuclear power plants, including those for decontamination, dismantling, and waste treatment as well as radiation measuring equipment, utilizing our core technologies for design, construction, maintenance, and preservation cultivated through our experience in nuclear power plant development. We are contributing to both the design of rational decommissioning plans and the accomplishment of actual decommissioning through the application of these technologies.

4S Small Fast Reactor and Fast Reactor Technologies
OTA Hiroyuki / FUKUIE Masaru

Toshiba has been developing a sodium-cooled small fast reactor named 4S (Super-Safe, Small and Simple) suitable for supplying energy to remote communities, mining sites, and so on, which requires no nuclear fuel replacement. We are promoting demonstration tests of innovative technologies related to 4S design such as electromagnetic pumps, electromagnetic flowmeters, and double-wall heat transfer tubes for steam generators, utilizing our sodium test loop facility. These 4S-related technologies and a long-life control rod under development will also be applicable to large-size fast reactors.

Activities toward Realization of Nuclear Fusion Reactor
SENDA Ikuo / OTA Hiroyuki / SATO Kiyokazu

With the aim of realizing a nuclear fusion reactor, experimental nuclear fusion reactors are currently under development through international cooperation.

Toshiba has been contributing to related domestic and international projects by supplying main equipment, as exemplified by the large superconducting magnetic coils for the Japanese Large Helical Device (LHD) project. We are currently manufacturing a vacuum vessel and participating in the assembly studies for the JT-60 Super Advanced (JT-60SA) Tokamak, which is a joint international research and development project involving Japan and Europe. We have also been engaged in research and development of equipment for the International Thermonuclear Experimental Reactor (ITER) Project in collaboration with seven countries including Japan, which has entered the construction phase, including the design work for the serial production of toroidal field coils and a remote maintenance system.

Next-Generation Heavy Ion Irradiation System
ONO Michitaka / OTA Hiroyuki / SATO Kiyokazu

Heavy ion radiotherapy systems for the treatment of cancer are currently under development in Japan and around the world, with the aim of overcoming refractory cancers and reducing the physical and mental burden on patients. The National Institute of Radiological Sciences (NIRS) has been developing heavy ion irradiation systems, and has completed the construction of new treatment facilities as a base for cancer therapy where treatment will commence at the end of fiscal 2010 applying a next-generation heavy ion irradiation system.

In cooperation with NIRS, Toshiba has developed three core technologies for next-generation heavy ion irradiation systems: a three-dimensional (3D) scanning irradiation system, a patient handling system using an arm-type treatment table, and a heavy ion treatment information system.

Fundamental Technologies to Support Nuclear Power Plants
NAKADA Kotaro / TAKAHASHI Masashi / HAGIWARA Tsuyoshi

With the aims of enhancing the safety and improving the economic performance of nuclear power plants, Toshiba has been developing the following new fundamental technologies to support the nuclear industry: (1) an advanced core and fuel analysis technology for next-generation reactors applicable to the design of an innovative fuel and core, which has more complex geometry than before; (2) an advanced material technology that can contribute to longer plant life through the development of durable materials that are able to withstand a high-radiation environment and reduce radioactive waste; and (3) a maintenance technology to support high performance in daily plant operation and extend operating life.

Frontiers of Research & Development