Power Systems

In the power systems field, Toshiba takes on the role of a pillar supporting social lifelines, aiming to construct a society where people can lead a secure and safe life. We promote more innovative development to offer large capacity, downsized and higher efficiency power systems backed by our years of experience with fundamental technologies in order to meet the globally expanding power demand and the urgent need for a reduction in the burden on the environment.

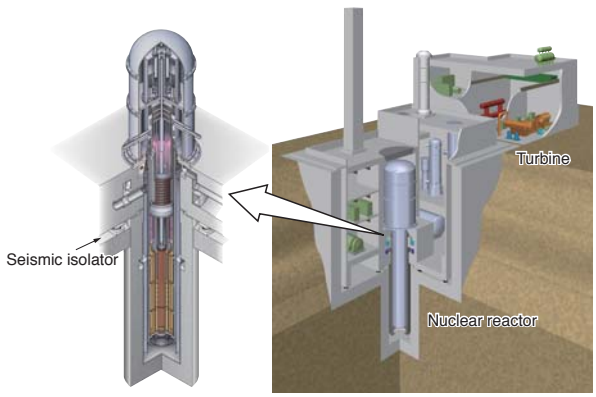
Development of 4S Small Liquid-Sodium Cooled Fast Reactor

Toshiba and Central Research Institute of Electric Power Industry have been developing a small liquid-sodium cooled fast reactor with inherent safety named 4S (Super-Safe Small and Simple), for which the power range is between 10 MW-electricity (MWe) and 50 MWe. This reactor can meet the various needs relevant to the region.

In 2006 FY, seismic evaluation was performed following the US regulation guide (Regulatory Guide 1.60, 1.61) for a global launch.

The modified design response spectra in the USNRC (United States Nuclear Regulatory Commission) regulatory guide, for which acceleration was increased in the low frequency area, was used in order to consider the effect of seismic isolation characteristics that are applied to this plant to ensure flexibility of site selection. Based on this result, it is confirmed that there is no need to change the basic structural concept by introducing the minimum anti-vibration equipment and enforcement of the stiffness of the reactor vessel part. These results were reflected in the PSID (Preliminary Safety Information Document).

These designs were reviewed by a US consulting firm and preparations for pre-application review by USNRC have been made.



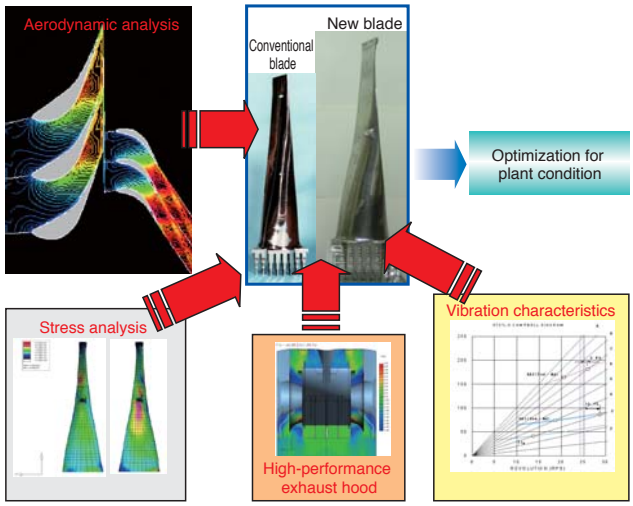
Concept of "Super-Safe, Small & Simple"(4S) small liquid-sodium cooled fast reactor

Development of a High-Performance Turbine Last-Stage Blade

Toshiba has completed analytical and lab-scale verification of a last-stage blade for use in steam turbines for next term nuclear projects and embarked on the final pilot phase for application in actual machines.

In the development of the blade profile, aiming at higher-performance using a long blade design utilizing our accumulated experience, we have optimized steam flow from the blade root to the tip and achieved a reliable structure by performing fluid analysis and structural and vibration analysis from the viewpoint of structure and aerodynamic design. Moreover, utilizing fluid analysis we have also developed a high-performance turbine exhaust hood shape.

We aim to apply these results in various nuclear power plants not only with next term large-capacity turbines but also with 1000 MWe to 1400 MWe class turbines in the future.



Technology for development of a last-stage blade for high-performance turbines

Development of Portable Laser Peening System

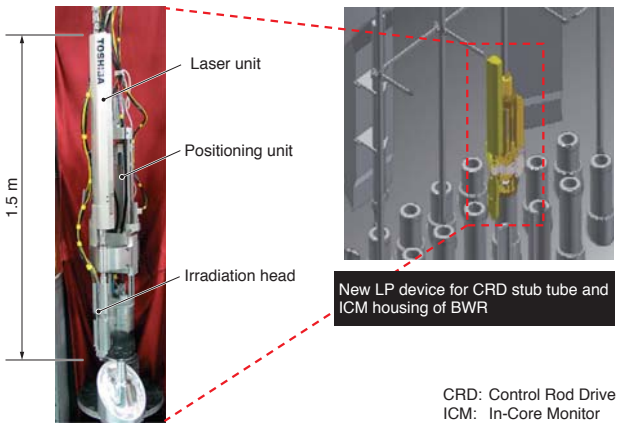
There are some areas that are susceptible to SCC (Stress Corrosion Cracking) in both types of nuclear plant reactor and internals, BWR (Boiling Water Reactor) and PWR (Pressurized Water Reactor). It is desirable to reduce the residual surface tensile stress to compression to prevent SCC occurrence in those areas.

Toshiba has developed a laser peening (LP) technology as a stress improvement method that has the effect mentioned above for use on reactor vessel and reactor internal components, and has already applied the technology in many actual nuclear plants.

Recently we have developed an advanced type of laser peening system incorporating a water resistant laser unit that includes a small laser oscillator and a laser light guide pipe with a mirror, with a positioning unit attached to both. This new system has the advantage of eliminating the conventional large laser container and optical fiber delivering laser energy.

It allows a great reduction in the floor space necessary for refueling in the field work by using a small laser oscillator. And by using a laser guide pipe with mirror to deliver the laser energy, the loss of laser energy is lower than that in the optical fiber delivery system with greater tolerance for laser irradiation and achieves essential robustness.

We believe this new system can make a great contribution to both domestic and foreign markets for nuclear plant preventive maintenance.



Portable laser peening system for BWR bottom

Matrixeye™ 3D Ultrasonic Inspection System and Application

The Matrixeye™, 3D ultrasonic inspection system can visualize a three-dimensional image of defects using high-speed parallel image synthetic processing of ultrasonic echo data collected by a linear or matrix-arrayed ultrasonic probe. The SAFT (Synthetic Aperture Focusing Technique) method developed for application in the Matrixeye™ achieves good resolution and S/N ratio. And its features are not influenced by probe frequency changes or distance from the probe.

The Matrixeye™ is applicable for the inspection of large-scale parts made from CFRP (Carbon Fiber Reinforced Plastics). A large-scale ultrasonic inspection system using the SAFT method has been commercialized for NDT (Non Destructive Test) in the manufacturing process for aircraft parts. This system can image foreign materials and delamination with good resolution automatically. On the other hand, the easy operation portable type Matrixeye™ is developed for manual inspections during service and after maintenance on aircraft bodies. The Matrixeye™ can image the delamination caused by impact with three-dimensional imaging. The figure below shows an image of delamination within CFRP.

Besides, it is possible to apply this in ultrasonic inspection systems for piping welding inspection using an angle beam method with a matrix-arrayed probe.

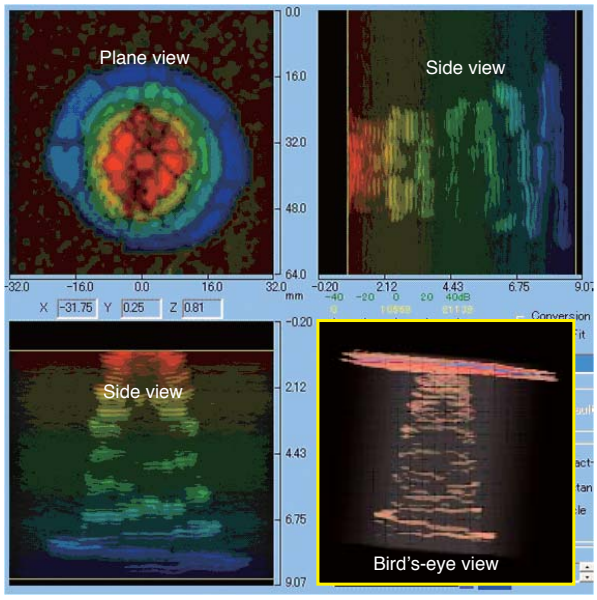


Image of delamination within CFRP
Test piece supplied by JAXA(Japan Aerospace Exploration Agency)

Installation of the Combined Cycle Power Train Futtsu Group 4 Thermal Power Plant with 1500°C Class Firing Temperature

Installation work for power train

While the power-train equipment for the 1st stage at Futtsu Thermal Power Station Group 4 of the Tokyo Electric Power Company is on the foundation and aligned, the piping and electrical work is in its final stage, and commissioning work toward the first fire up in November 2007 has started.

Futtsu Group 4 is a more advanced combined cycle power station that applies a 1500°C class firing temperature(*1).

Toshiba designed and manufactured the steam turbine and generator, and also manufactured the GE (*2) -designed compressor under the H System™ RSP (Risk and revenue Sharing Participation) agreement for all three stages of Group 4. Furthermore, Toshiba will provide the auxiliary equipment and perform the installation/commissioning work for all of the equipment for the first two stages.

The power train consists of a tandem compound 2 casing double-flow, reheat condensing steam turbine, a 3-phase alternating current, water-cooled, synchronous generator, and the 9H gas turbine, which has a closed-loop steam cooling system to achieve higher firing temperatures leading to higher efficiency. The control and monitoring system is achieved through a combination of a TOSMAP-DS PLUS™ series controller and Speedtronic™ Mark™ VI series controller.

(*1) Based on METI application

(*2) General Electric Company

"H system", "Speedtronic" and "Mark" are trademarks of General Electric Company.

Shipment of generator from factory

Super Stage Test

Successive Orders for Steam Turbine Generators with Advanced Technology for Fossil Fuel Power Plants in North America

Toshiba received an order for a super-critical coal-fired steam turbine generator for Iatan unit 2 of the Kansas City Power & Light Company (KCP&L) in North America in April 2006. This is the fruit of our orders-received track record that gives Toshiba the No. 1 share in the U.S. market and a reputation for stable operation of super-critical coal-fired power plants all over the world, which is held in high esteem by customers who have purchased our machines.

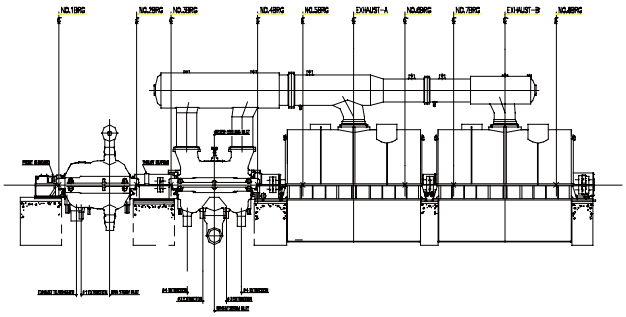
The steam turbine generator has a rated output of 914 MW and this makes it one of the largest output coal-fired steam turbine generator 60-Hz tandem compound machines in the world.

The plant features are as follows:

- Adoption of a high-performance 40-inch steel last stage blade and the latest improved steam path design.
- Scheduled to be provisionally accepted in May 2009

Other orders for a super-critical coal-fired steam turbine generator are as follows:

- Cliffside unit 6 of Duke Energy in February 2007
- Prairie State Energy Campus Project units 1 and 2 of Prairie State Generating Company LLC in April 2007



Mechanical outline of super-critical coal-fired steam turbine

Accomplishment of 2P-50 Hz 1000 MW Turbine Generator

In China, many large thermal coal-fired super critical power plants are planned due to the rapid economic development.

The consortium of Harbin Electric Machinery Co., Ltd. (HEC) and Toshiba Corporation has received orders for two 1000 MW thermal power units for China Guodian Taizhou Power Co., Ltd.

The design and machine manufacturing for the first 1000 MW generator were performed by Toshiba and the second generator is being manufactured by HEC. In the design stage, special attention was paid to higher operability and maintainability as well as reliability and performance. The combination of high efficiency and compact design technology has achieved both a reduction in weight and a guaranteed efficiency of 99.00%. The compact and high efficiency tandem 2-pole, 50 Hz, 1000 MW turbine generator has been successfully completed for shipment to the Taizhou thermal power station in China.

1000 MW generator at shop test

Start of Operation of DCS Utilizing the TOSMAP-DS™ for Overseas Thermal Power Plants

Toshiba successfully completed the takeover of the thermal power plants Tanjung Bin (3×700 MW) unit 1 in Malaysia and Tanjung Jati B (2×710 MW) units 1 & 2 in Indonesia in the period from September to November 2006.

These power plants started commercial operation with a DCS (Distributed Control System) utilizing the TOSMAP-DS™ that is a state-of-the-art system developed for power plant control and monitoring purposes.

The TOSMAP-DS™ is a total control and monitoring system, and its monitoring and control functions cover not only boiler, turbine and the generator proper but also the balance of the plant and environmental facilities such as FGD (Flue Gas Desulphurization) and CEMS (Continuous Emission Monitoring System).

The TOSMAP-DS™ applied for these power plants will be of the standard type for large-scale conventional coal-fired power plants of EPC (Engineering, Procurement and Construction) contract.

The TOSMAP-DS™ accomplishes comprehensive and seamless integration of high-speed control such as turbine governor and generator control. As a power plant supplier and turbine/generator manufacturer, Toshiba will continue to supply DCS featuring high cost performance, excellent operation and monitoring function.

Operator stations of TOSMAP-DS™ for Tanjung Jati B Power Plant, Indonesia

Shipment of Pump-Turbine Stationary Parts for Chinese Pumped Storage Power Station

The pump-turbine stationary parts for the first unit (No.4) and second unit (No.3) for the Xilongchi Pumped Storage Project in China were confirmed to have sufficient quality in witness shop assembly inspections in May and October 2006 respectively, and shipped.

The power station for this pumped storage project consists of four pump-turbine units and is constructed at Shanxi province in China. The pump-turbine is a world top class high head and large capacity machine, with the maximum pumping head of 703 m and turbine output of 306 MW.

A Japanese consortium with three heavy industry manufacturers and a trading company was formed for this project. Since the pump-turbine is required to be highly reliable because of the high head, some components had to be made in Japan and Toshiba manufactured most of these components. The components manufactured by another consortium member are carried to Toshiba's factory and assembled together with components manufactured by Toshiba in order to confirm their quality.

The inlet valve of the first unit (No.4) was also shipped after confirmation of quality and performance in a witness test in December 2006.

Installation work has already begun on site to start commercial operation in August 2008.

The remaining pump-turbine stationary parts of No.1 and 2, runners, inlet valves, and generator-motor parts will be manufactured and shipped in order.

Factory assembly of pump-turbine for Xilongchi Pumped Storage Power Station

Factory assembly of inlet valve for Xilongchi Pumped Storage Power Station

Completion of 400 kV Brazi Vest Substation Upgrading Project (Stage-1) for Romania Transelectrica S. A.

Toshiba completed the construction of the 400 kV substation, the first stage of the upgrading project of 400/220 kV Brazi Vest Substation for the Romanian National Power Grid Company Transelectrica S. A. in April 2006, followed by its successful energization in May 2006.

This project is based on a full turn key contract, for renewal of the deteriorated existing air-insulated substation, and includes the supply of the entire substation equipment such as 420 kV and 245 kV gas-insulated switchgear (GIS), digital substation control & monitoring systems, protection systems, all civil & erection works, testing, and commissioning of all primary and secondary apparatus.

This substation is an important node in the power transmission network and it was necessary to install new facilities in the limited space available without any outage of the existing substation. Furthermore, the substation is located in an industrial area with air-pollution. GIS, with its proud reputation for compactness, safety, environmental conformity, and antipollution performance, was the total solution to satisfy all those demands here, and was introduced for the first time into the Romanian power transmission network through this project.

420 kV gas-insulated switchgear (GIS) at Brazi Vest Substation, Romania

Seven 400 kV Large Scale Substation Projects Being Executed One After Another in the United Arab Emirates

Development in the United Arab Emirates, especially its Capital Abu Dhabi, has encouraged the utility to extend and enhance the 400 kV power network. In this background of rising demand for electricity, Toshiba has been successively awarded seven tenders for 400 kV large scale substations on a full turn key basis by the utility since 2003:

- E48, 400/132 kV Substation
  Awarded in March 2003, and energized in May 2005
- Um Al Nar, 400/132 kV Power Station
  Awarded in July 2003, and energized in March 2005
- Abu Dhabi Station (ADST), 400 kV Substation
  Awarded in May 2004, and energized in March 2006
- Medina Zayed, 400/220 kV Substation
  Awarded in June 2004, energized in June 2006
- Sweihan, 400/220 kV Substation
  Awarded in January 2006, and under construction
- Fujairah, 400/132 kV Substation
  Awarded in February 2006, and under construction
- Ras Al Khaimah, 400/132 kV Substation
  Awarded in July 2006, and under construction

While the above projects have been executed simultaneously, Toshiba aims to complete all the projects successfully, making the best use of efficient project management and quality assurance based on continuous project executions. Thus Toshiba's experience and endeavor will contribute to the utility to ensure a reliable power supply in the United Arab Emirates.

View of 400 kV Substation at Medina Zayed

The IEC 61850-Compliant GRZ100 and the KEMA Certification

IEC 61850, the new communication standard for power systems, is now being used ever more widely in practical applications. Toshiba developed the IEC 61850 communication function and applied it first of all in the GRZ100 distance relay. Subsequently, the GRZ100 was certified by KEMA, an independent test laboratory, in July 2006.

In August 2006, Toshiba participated in the UCAIUG (UCA International User Group) interoperability demonstration at CIGRE Paris, during which the GRZ100's GOOSE messaging function was observed to achieve faster performance than all other participating vendors.

The IEC 61850-compliant GRZ100 was first shipped in March 2007. Toshiba will apply the IEC 61850 communication function to our other protection and control products.

CIGRE: International Conference on Large Electric System
GOOSE: Generic Object Oriented Substation Event

GRZ100 multi-functional distance relay

IEC 61850 certificate for the GRZ100