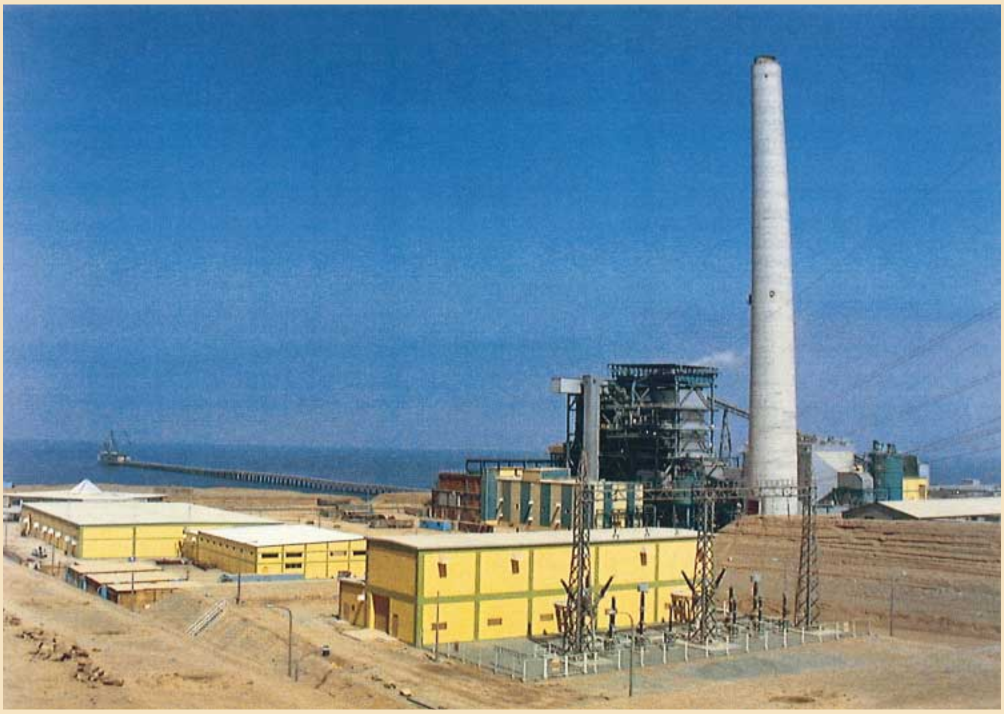
Power Systems

The importance of electric power as an energy source continues to increase in the 21st century. Challenges in this area include deregulation and environmental issues. In addition, we must aggressively expand the use of information technology in thermal and nuclear power systems, which are the main energy sources in our country. In 2000, along with its main strategy to develop more sophisticated global systems with higher efficiency and reliability, Hitachi continued to promote technological development in this area.

Peru, ILO No. 2 Thermal Power Plant — 125-MW Coal-fired Unit No. 1



Peru, ILO No. 2 Thermal Power Plant—125-MW Coal-fired Unit No. 1

The construction of the ILO No. 2 (ILO2) Thermal Power Plant, 125-MW Coal-fired Unit 1, was successfully completed and the unit was put into commercial operation on October 10th, 2000. This plant is the first full turnkey project, won and executed solely by Hitachi, Ltd., and is also the first coal-fired plant in Peru.

Construction of the civil works for ILO2 Thermal Power Plant Unit 1, located on the seaside about 20 km from ILO City, started in June 1998. Upon completion of the erection works, the boiler was first lit on May 5th, 2000, and following a period of commissioning, the Unit was successfully put into commercial operation on October 10th, 2000. The power plant is electrically connected to the Southern Interconnected Power System (SIS) and supplies the bulk of its generated power to the neighboring Southern Peru Copper Corporation (SPCC), with whom the owners of the ILO2 plant, ENERSUR, have a power purchase agreement. Hitachi, in addition to supplying the turbine, generator, boiler, and electrical and control equipment for the main power block, also supplied and constructed all the civil works, administration and service buildings, coal handling facility, and a jetty into the sea for coal unloading and to serve as a trestle for the circulating water (CW) pipes. Hitachi also performed training and met other specified requirements.

The main features of the plant are summarized as follows.

(1) Use of external expertise for effective risk management.

(2) Design and construction of a 1,300-m jetty into the sea for coal unloading and to serve as a trestle for CW pipes.

(3) A semi-siphon CW system whose intake mouth is located about 800 m out into the sea. The sea water is siphoned through the CW pipe into a CW intake pit on the shore, which acts as the first collection pit. Adopting this siphon system produces considerable auxiliary power savings.

(4) The plant is located 25 m above sea level and the sea water is pumped up to the condenser, desalination plant, etc. The sea water, after passing through the condenser and other heat-exchanging equipment, is returned to the sea through an open culvert spillway. Two weirs installed at the bottom of the spillway cause hydraulic jumps to limit the sea water discharge velocity into the sea.

(5) Atmospheric dust emission and effluent discharge into the sea are limited to the levels set by the World Bank Regulations, due to the installation of an electrostatic precipitator and a waste water treatment plant.

(6) Potable water and all fresh water essential for operation of the plant are produced by two 100% multi-stage steam compressor desalination units.

(7) The project was completed within the stipulated period of 30 months and involved precise coordination and control of engineering, manufacturing, shipment, installation, and commissioning of products from 235 subcontractors in 24 countries.

(8) All contractual guarantees were met, thus avoiding all specified liquidated damages.

250-MW PFBC Power Plant Starts Commercial Operation in Japan

Bird's-eye view of the 250-MW PFBC power plant delivered to the Chugoku Electric's Osaki Power Station

The 250-MW pressurized fluidized-bed combustion boiler combined-cycle (PFBC) power plant (Unit 1-1 of Series 1) that was delivered to the Osaki Power Station of the Chugoku Electric Power Co., Inc. has gone through test operations smoothly. This is a highly reliable and efficient large-capacity power plant.

In its efforts to develop the present plant from design and construction to installation and test operations, the Hitachi Group had comprehensive discussions with the Chugoku Electric Power Co., Inc., including a joint study at the 4-MW test plant of the company's Thermal Power Generation Technical Center. Construction of the plant proceeded smoothly and it was put into commercial operation in November, 2000.

The PFBC system has the advantages of offering good environmental performance and not requiring a large construction site. Hitachi, Ltd. delivered a complete set of power generation equipment, including the PFBC boiler, steam turbine, gas turbine, generator, heat exchanger for waste heat recovery, electrical control equipment, etc.

Salient features of the PFBC power plant are as follows.

(1) The boiler is divided into an SH furnace and an RH furnace (the first time for a PFBC system). It is a twin-furnace type (W.B.). Two pressure vessels, each housing one furnace, were installed. The bed material (BM) tanks for adjusting bed height and the cyclones were installed outside the pressure vessels to facilitate maintenance and inspection and improve the controllability of plant operation. A wet-type coal feed system is used to supply the boiler with coal and limestone.

(2) The gas turbine is a similar type to the one installed at the Chugoku Electric's Yanai Power Station, but it was also modified for PFBC operation. Namely, to ensure that the turbine blades could withstand the coal ash-bearing hot gas (at approximately 840°C) from the boiler, both the rotating blade and stationary blade thicknesses were increased and the blade coatings were improved. The gas turbine is started by the combination of an exclusive motor and exclusive combustors.

(3) Limestone is put into the boiler furnace to remove sulfur from the coal in the furnace, and ammonia gas is blown into the furnace outlet to decompose nitrogen oxides contained in the flue gas without using any catalyst. Nitrogen oxides are further removed from the flue gas by a catalytic denitrification device installed in the middle of the heat exchanger for waste heat recovery.

Completion of a State-of-the-art Coal-fired Boiler Facilities

State-of-the-art coal-fired boiler facilities
Top: Electric Power Development Co., Ltd.
Bottom: Shikoku Electric Power Co., Inc.

Coal thermal power plants of the maximum class capacity in Japan, operated by Shikoku Electric Power Co., Inc. and Electric Power Development Co., Ltd., have been completed on Kokatsu Island in Tachibana-cho, Anan City, Tokushima Prefecture. Commercial operation began in June, 2000 and December, 2000 respectively.

Specifications

The 700-MW coal-fired boiler plant for the Tachibanawan Thermal Power Station of Shikoku Electric Power Co., Inc.:

(1) Type: super-critical pressure reheat-type boiler
(2) Evaporation: 2,250 t/h
(3) Steam conditions: 24.1 MPa, 566/593°C

The 1,050-MW coal-fired boiler plant for the Tachibanawan Thermal Power Station Unit No. 2 of Electric Power Development Co., Ltd.:

(1) Type: Super-critical pressure reheat-type boiler
(2) Evaporation: 3,000 t/h
(3) Steam conditions: 25.0 MPa, 600/610°C

Features

(1) To make the facility highly efficient, high-temperature, high-strength materials were used for the superheater and reheater.
(2) For high-efficiency combustion and environmental protection, a Hitachi NR-2 burner and MPS-300 mill (pulverizer) with 2-step-type rotary separator were applied.
(3) Increased-capacity light oil equipment was used for boiler start-up and 50%-load operation, and heavy oil equipment was omitted.
(4) For effective operation monitoring, a hierarchical distributed digital control system was adopted to reduce the number of operators.

H-25 Gas Turbine Power Plant for LGPC in Korea

H-25 gas turbine at LGPC Yosu Plant

An H-25 gas turbine power plant had been installed and commissioned at the Yosu Plant of LGPC (LG Petrochemical Co., Ltd.) in Korea. It was put into commercial operation on Sep. 16, 2000. Hitachi provided the gas turbine control system and off-gas compressor.

The H-25 gas turbine was developed by Hitachi, Ltd. in 1988, and an initial total of 10 units was supplied to Japanese customers. The LGPC plant received the first exported H-25 gas turbine unit. Following these units, a total of 13 units are being installed or manufactured for customers in Bangladesh, Canada, and Nigeria.

Specifications of major equipment are summarized below.

(1) Gas turbine output : 23.56 MW
(2) Gas turbine type: H-25, heavy-duty gas turbine
(3) Gas turbine fuel: MOG (methane off-gas)
(4) Exhaust gas: to existing ethylene cracking heaters for heat recovery
(5) Control system type: digital control system
(6) Off-gas compressor type: reciprocating compressor

China/Wuling Hydropower Development Corporation The Lingjintan Hydroelectric Power Plant's Bulb Turbine and Generator

Specifications of bulb turbine	Specifications of generator
Rated output: 30,930 kW	Rated capacity: 31,580 kVA
Maximum net head: 13.2 m	Rated voltage: 10.5 kV
Speed: 78.9 min^{-1}	Speed: 78.9 min^{-1}
Specific speed: 737 m-kW	No. of poles: 76 poles
Type: HK-1RT	Frequency: 50 Hz
No. of units: 9	Type: TTFFC1, LW-RD

Lingjintan Hydroelectric Power Plant Unit No.1: shop assembly of bulb turbine and main specifications

A bulb turbine is a turbine of the tubular type. It consists of a turbine and generator in a bulb-shaped body, which is installed in the water. The bulb turbine has been assumed to be the most beneficial and economical way of developing the hydraulic energy from an ultra-low head area.

Hitachi was awarded the contract for a total of 9 bulb-turbine units including the generators as the partner in a consortium with Harbin Electric Company in 1995.

This power plant has one of the widest head variations in the world. Hitachi successfully developed the most suitable hydraulic performance for the power plant. The power plant is subject to structural strength because the plant is so large. Hitachi also achieved a high level of safety through static/dynamic stress analysis, displacement, fatigue analysis, vibration analysis, etc.

The newest technologies have been adopted for the generator. For example, in the secondary cooling system adopted in the cooling ring, the outer surface is exposed to river water.

All 9 units have started operation in December, 2000. It is expected that the bulb turbine will be important in the sphere of economic development because of its ultra-low head and big flow area and that the design and manufacture of this power plant will contribute to the development of hydroelectric technology.

GO TO THE RELEVANT SITE

5,070-kW Kaplan Turbine-generator and Electromotive Blade-operating Mechanism for Miyoshi Power Station, Kyushu Electric Power Co., Inc.

Specifications of the turbine and generator unit

Kaplan turbine		Generator	
Output	5,070 kW	Capacity	4,850 kVA
Effective head	12.36 m	Frequency	60 Hz
Max. discharge	47.3 m³/s		
Speed	200 r/min		

View of the generator and specifications of Kaplan turbine-generator

Recently, due to concerns about maintenance simplification and environmental protection, electromotive devices have been adopted as oil-free operating systems for guide vanes. Such devices have been adapted to Kaplan turbines.

On the other hand, a conventional mechanism using pressured oil has generally been used to operate the runner blade of a Kaplan turbine, because it is not easy to install a complicated operating mechanism in the rotating part where space is limited.

To meet the requirement for maintenance simplification, an electromotive blade-operating mechanism and system that can be installed in a rotating part were developed by Hitachi, Ltd. and Hitachi Engineering & Services Co., Ltd. This electromotive mechanism was adapted to a Kaplan turbine for the Miyoshi Power Station. The mechanism consists of a variable speed motor, connection device, speed reduction device, roller screw, and so on.

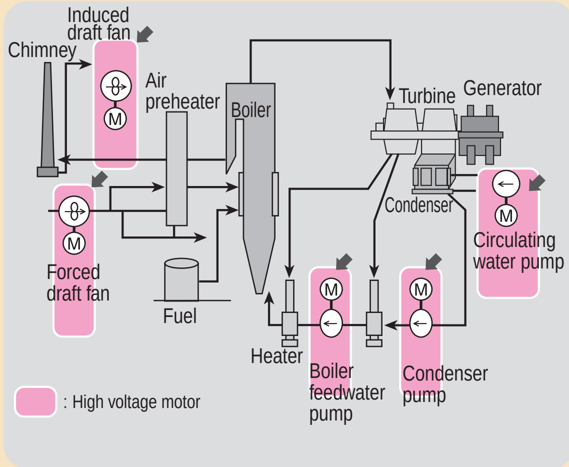
In accordance with the operating pattern required by the power station, the angle of the runner blade is adjusted by using the programmed difference between the rotation speed of the main shaft, connecting the runner with the generator, and that of the variable speed motor that produces this difference. The difference in rotation speed is converted into movement in the axial direction and then transmitted to the runner blade for control.

In addition, an emergency closing device for the guide vane operating system was also adopted. The electromotive servomotor for the guide vane operation is mounted on the base, which enables the guide vanes to be closed by sliding the servomotor itself using electric power, in case of trouble with the servomotor.

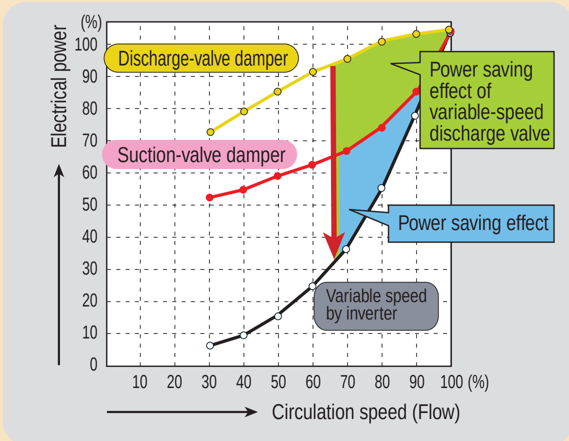
Furthermore, to simplify maintenance and achieve environmental protection, the other recent technologies were adopted for the turbine-generator. Ceramics were used for the water sealing device in the turbine. A synthetic resin for the thrust bearing and an air-cooled system for the lower guide and thrust-bearing unit were used in the generator.

Thus, the Miyoshi Power Station has been renovated according to the concepts of thoroughly simplified maintenance and environmental protection. The renovated plant was commissioned in August 2000.

Reduction of Auxiliary Power Consumption by Inverter



Large auxiliaries driven by motor in a thermal power plant



Comparison of auxiliary power

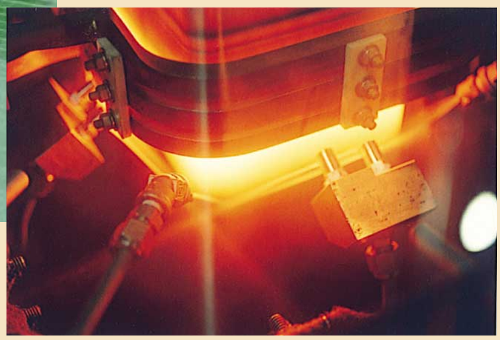
Structure of high-voltage direct inverter

A thermal power plant has many facilities that are driven by motors that consume a huge amount of electricity produced by the power plant itself.

As a result of the development of power-electronics technologies, inverter technology can be applied not only to low-voltage electric motors (400-V class) but also to high-voltage motors (3.3 to 6.6-kV class), which are used as drivers in a thermal power plant. Hitachi, Ltd. has developed a high-voltage direct-inverter drive system that enables variable-speed operation of a high-voltage motor. This drive system is able to reduce the huge power consumption and CO_2 generation.

BWR Fuel Channel Boxes Exceed 20,000 Units Shipped

Inspection process of the new FCBs



Special heat treatment at the stage of the square shell

Hitachi has been producing FCBs (fuel channel boxes) for BWRs (boiling water reactors), and the total number of units shipped has reached over 20,000. Hitachi's new process for beta-quenched FCBs was verified to have an anti-irradiation deformation effect. The expectation has been raised that the new FCBs are applicable to production with high burn-up fuels.

The total number of FCB units shipped reached over 20,000 in June 2000. This was accomplished by the combination of productive work and technological development over 23 years. As FCBs are one of the key components in nuclear reactors, Hitachi has always delivered reliable FCB products by using dedicated fabrication line and strict quality control.

FCBs are unique to BWRs, and are assembled to cover fuel bundles and be used in reactor cores, to define the coolant flow paths of individual fuels, and to secure the space envelopes for control rod insertion. An FCB consists of a thin-wall shell with a square section, approximately 4.2 m in length, 14 cm in outer width, and 3 mm in thickness, with strict dimensional accuracy. Zirconium alloys are used because they have low thermal neutron absorption and sufficient mechanical properties under the high-temperature conditions in the reactor.

Hitachi has been further developing the technology for high-performance FCBs, especially in terms of improving the irradiation properties of zirconium alloys, because higher corrosion resistance and greater structural stability correspond to high fuel burnups and extended operation cycles.

Zirconium alloys have unique properties such as a crystal structure that (1) turns into a uniform orientation through manufacturing processes such as rolling or pressing, and (2) deforms in a certain direction due to neutron irradiation in the reactor core. These zirconium alloy material characteristics would result in deformation such as FCB bowing under irradiation.

Hitachi has developed a new technology that enhances the structural stability of irradiated FCBs. A technology that improves material properties has been achieved by using a special heat treatment at the stage of the square shell. This is performed by using a quenching heat treatment at the beta-phase field temperature (over 1,000°C) with high-frequency induction heating and rapid cooling in water. Through this process the microstructure of the zirconium alloy is changed to a random crystal orientation, so that the deformation of the irradiated FCB is controlled. In addition, this beta-quenched process optimizes the dispersion of alloy elements into the material, thus improving the resistance to corrosion in the reactor environment.

Hitachi has verified the improvements in structural stability and corrosion resistance by conducting demonstrations in several reactors, and commercial use has begun. This beta-quenched FCB is a good solution for high burnup BWR fuels and is also expected to be a reliable technology.

Fuel Storage Rack Using High-density Borated Stainless Steel Delivered

Existing stainless-steel rack detached from SFP

New high-density BSS rack installed in SFP

The first stage of construction to increase the capacity of the spent-fuel storage pool of the Shimane Nuclear Power Station Unit-2 of Chugoku Electric Power Co., Inc. by replacing the fuel storage rack has been completed.

To increase the capacity of a fuel storage pool whose size could not be changed, the fuel storage rack was replaced with a newly developed one. Stainless steel with 1-wt% boron was used for the newly developed rack. The existing fuel storage racks were replaced by the new ones in a fuel storage pool with an 11-meter water-depth by remote operation.

The spent fuels generated in nuclear power plants are stored and managed in spent-fuel storage pools (SFPs) in reactor buildings until they are shipped to a reprocessing plant. Construction to increase the storage capacity of the spent-fuel storage pool at Shimane Nuclear Power Station Unit-2 by replacing the fuel storage racks is currently proceeding. The spent fuels will eventually be transported to Japan Nuclear Fuel Limited's Rokkasho Reprocessing Plant, which is now under construction in Aomori Prefecture. To ensure steady operation with increased storage capacity, this construction at Shimane has begun.

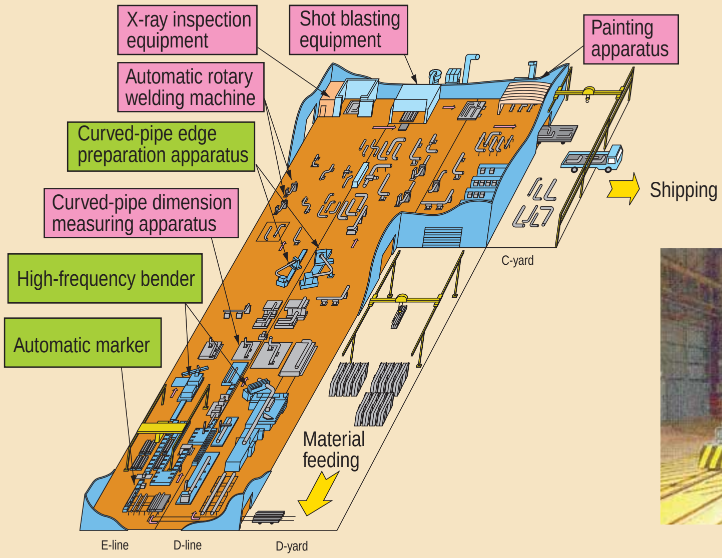
To increase storage capacity, since the size of the SFP itself is limited, the spent-fuel storage racks should be built geometrically and densely so that fuel bundles can be put as close as possible to one another. However, in designing and manufacturing high-density spent fuel rack, criticality must be prevented. For this reason, borated stainless steel (BSS: stainless steel with boron added to provide excellent neutron absorption characteristics) has been used instead of standard stainless steel.

In response to further demands for higher density BSS racks, Hitachi has produced new high-density racks in which the boron density has been increased to around 1-wt%, the highest level yet produced in Japan. By applying this high-density BSS rack, the SFP capacity can be increased to 1.5 times the current level at Shimane Nuclear Power Station Unit-2.

Because more boron is added, BSS cracks more easily, so adopting a square tubular structure for a high-density BSS rack is difficult. In addition, the size accuracy of each part must be strictly controlled. In the course of developing and producing the new high-density BSS rack, various mock-ups were tested, and as a result, original manufacturing technologies were established.

To increase SFP storage capacity, the existing stainless-steel racks in 11-meter-deep water are removed by remote operation from outside the pool, and the new high-density BSS racks are then installed. At Shimane Nuclear Power Station Unit-2, the construction is scheduled for three stages between 1999 and 2002. The first stage of construction was completed in June 2000.

Completion of New Piping and Nuclear Module Production Factories



Inner view of the piping production factory (right) and a high-frequency induction heating pipe-bending machine for large bore piping (left)

Module factory (inset) and inside of the factory

(1) Piping Production Factory

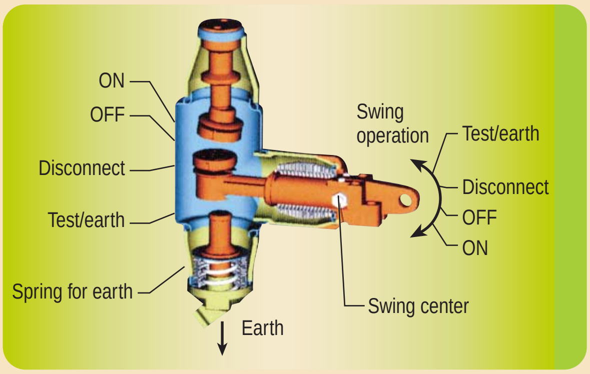
Hitachi's Nuclear Systems Division has invested heavily in piping and module production factories to establish effective production systems for the multi-plant construction era in the future.

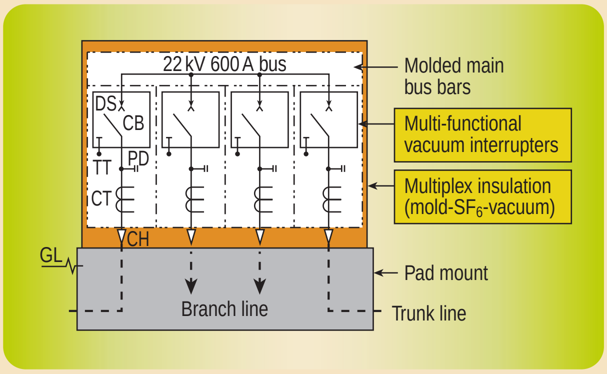
In the case of the piping production factory completed in July 2000, the building was expanded for consecutive production lines (material acceptance, preliminary machining, arrangement, testing, and shipping) and existing factories were modified (e.g. high-frequency induction heating bender) to enhance production capacity. In addition, the products fabricated in the factory were streamlined and a new production management system was introduced, which enormously reduced lead time. The maximum production capacity (3,600 tons/year) is twice as much as the previous one. Piping manufacturing for Hamaoka Nuclear Power Plant Unit 5 (Chubu Electric Power Co., Inc.) began in September 2000.

(2) Nuclear Module Production Factory

In September 2000, the construction of the Nuclear Module Production Factory at Hitachi Port No. 4 quay was completed and module production began. The modules are prefabricated compound products consisting of equipment, pipes, valves, etc. Some of the piping fabricated at the new Piping Production Factory is sent to the Nuclear Module Production Factory and assembled in modules. The factory includes special assembly equipment, such as automatic horizontal level control devices and intelligent piping welding systems. It is also now possible for engineers to share design data through the company network. This has enabled engineers to communicate quickly with each other and reduce the amount of paperwork. 3D-CAD systems with large displays are used to visualize design data within the factory. This equipment improves work efficiency. For future nuclear power plant construction, Hitachi, Ltd. will try to achieve more rationalistic construction by extending module extent and quantity.

24-kV Switchgear with Multi-functional Vacuum Interrupters for Power Distribution





24-kV four-circuit switchgear with multi-functional vacuum interrupters (upper left), swing operation type multi-functional vacuum interrupter (upper right), and single line diagram (lower)

To step up 6-kV distribution voltage to 20-kV distribution and prevailing it, Hitachi, Ltd., and Tokyo Electric Power Co. (TEPCO) have co-developed switchgear featuring a swing-operated multi-function vacuum interrupter and supplied it to 29 sites (129 circuits in total) including Rainbow Town in Rinkai Fukutoshin, Tokyo.

In Japan, this switchgear is mainly used for power receiving in normal/standby and/or spot-network systems. However, as it has an interrupting capability and remote control function, it is suitably applied for a closed-loop ring main system. In combination with an intelligent digital unit having functions as a field-terminal unit, communication according to the protocol DNP3.0, and digital protection, it will be effective in application to the automation of distribution.

The ratings of the developed switchgear are 24 kV, 600 A, and 25 kA. This switchgear, in a single unit, has functions equivalent to those of conventional units with a motor-operated circuit breaker (CB), disconnect switch (DS), and cable testing/earthing switch (ES). The cubicle size for a circuit is 360 mm wide, 450 mm deep, and 1,450 mm high, reducing the volume to one tenth of the conventional value.

The main new technologies are listed below.

(1) The vacuum interrupter, the world's first structure, provides a swing-operation through 4 positions; ON–OFF–Disconnect–Cable test/earth of moving contact to have functions of CB, DS, and ES.

(2) Multi-insulations by epoxy mold, SF_6 gas, and vacuum.

(3) Operating mechanism controlling 4 positions, ON, OFF, Disconnect, and Test/earth.

New Digital-type Protection and Control Units

Protection and control unit

There has been an increasing need for protection and control units for electric power systems to support digital processing technology and IT (information technology). At the same time, these units have been required to comply with the world's standard communication interfaces.

Hitachi has developed new digital-type protection and control units by using our eighty-year background of experience in the field of substation protection and control. These new units are equipped with 32-bit RISC (reduced instruction set computer) processors, have Web server functions, and comply with the standard communication interfaces, IEC (International Electrotechnical Commission) 870-5 and DNP (Distributed Network Protocol) 3.0.

Major features are as follows.

(1) Compact unit structure achieved by installing the 32-bit RISC processor.
(2) Loose coupling connection of modules, such as the protection and control modules.
(3) Increased reliability achieved by using self-checking functions, such as the error checking and correcting function, and 12th-harmonic waveform supervision for analog inputs.
(4) Web server function using Internet technology.
(5) Compliance with the world's standard communication interfaces, such as field LAN (Local Area Network) , IEC870-5, and DNP3.0.

1,400-MW Kii-channel HVDC System

The 700-MW thyristor valve (250-kV/2,800-A quadruple-valve unit)

The Kii-channel HVDC (high voltage direct current) system is the largest HVDC system in Japan, and the first HVDC system for bulk power transmission in Japan. It is used to transmit part of electric power via submarine cables from the Tachibanawan Thermal Power Plant on Shikoku island to Honshu island located in the central region Japan.

The Kii-channel HVDC system was constructed by the Kansai Electric Power Co., Inc., Shikoku Electric Power Co., Inc., and Electric Power Development Co., Ltd.

Hitachi, Ltd. developed, manufactured, and supplied the 700-MW thyristor valves, 872-MVA converter transformers, control and protection panels, and other equipment for the Anan and Kihoku converter stations, both terminals.

The thyristor valves, which are the main equipment for the converter stations, were designed to be small and low-loss, with 8-kV/3,500-A direct light triggering thyristors (LTT's). The control panels have new functions for power system control, such as continuous operation during AC system faults and power modulation with the latest digital control technology. This system has been in commercial operation since June 2000.

OpenPLANET Remote Station Server

OpenPLANET Remote Station Server

In collaboration with Shikoku Electric Power Co., Inc. and Shikoku Instrumentation Co., Ltd., Hitachi, Ltd. has developed a low-cost, compact server called the OpenPLANET Remote Station (OP/RS) Server. This server will enable low-cost construction of systems based on existing OpenPLANET technology for remote monitoring and control of all types of industrial and office-use electrical equipment.

Based on the OpenPLANET WHM (watt hour meter) server model, the OP/RS server features Hitachi's SuperH series RISC microprocessor and a custom LSI at its core. This compact, high-performance hardware runs embedded Java* software to enable remote control in real-time. In addition, the OP/RS server can handle several communication interfaces, such as a PHS (personal handyphone system) modem, Ethernet**, and LON I/F, and is fully interoperable.

Field tests of the OP/RS server used in heat-storage facilities and hydro-electric power plants commenced on Shikoku Island in November, 2000. Applications utilizing the server will be extended to a wide range of fields such as monitoring systems for company housing and dormitories as well as agricultural equipment.

* Java and all Java-based trademarks and logos are trademarks or registered trademarks of Sun Microsystems, Inc. in the US and other countries.
** Ethernet is a registered trademark of Xerox Corporation in the US.

GO TO THE RELEVANT SITE

DORA-Power: A Remote Monitoring System for Total Dam Management at the Hyuga Power Office of Kyushu Electric Power Co., Inc.

Total-dam-management system at the Hyuga Power Office of Kyushu Electric Power Co., Inc.

Hitachi has developed a middleware called DORA-Power (dependable and open real-time architecture for power systems). The first system in which DORA was applied, for dam control, has been operating since December 2000 at the Hyuga Power Office of Kyushu Electric Power Co., Inc.

Its main features are as follows.

(1) Industrial PCs (HF-Win) running Windows NT* are used. This contributes to a less expensive hardware solution while maintaining a high reliability for the operator to handle the monitoring and control of the entire dam.

(2) The Autonomous Decentralized Service System (ADSS) concept and Plug & Play systems, industry-standard open interfaces, enable easy linkage of and cooperation between systems.

(3) DORA-Power middleware in the application system allows utilities to maintain highly reliable operations.

The DORA-Power and ADSS concepts are expected to strongly enhance the information and control business field.

* Windows NT is a registered trademark of Microsoft Corporation in the U.S. and other countries.