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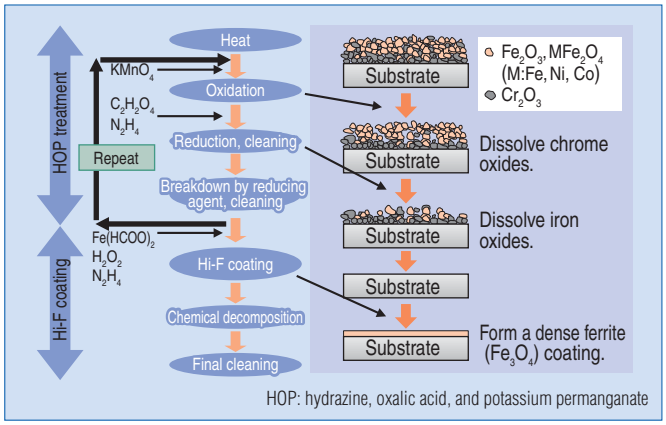
Hi-F Coat Technology for Coating Interior Pipe Surfaces to Improve Safety of Workers at Nuclear Power Plants

Reducing the radiation dose to which workers at nuclear power plants are subjected during maintenance work has a role in improving safety at these sites. Hitachi has developed a ferrite coating called Hi-F coat for treating the interior surfaces of piping at nuclear power plants and has trialed its use in actual plants to confirm its effectiveness at reducing radiation dose rate by minimizing the adhesion of radioactive material to the insides of pipes. The product will contribute to improving the safety of nuclear power generation, a field that is attracting attention worldwide for its ability both to provide reliable energy supplies and help mitigate global warming.



Overview of Hi-F coat treatment procedure

Further Improvements to Safety at Nuclear Power Plants

Nuclear power generation can supply large quantities of electric power without releasing any CO_2 (carbon dioxide) in the generation process and it is anticipated that this ability to provide a reliable energy supply while also helping mitigate global warming will see it taking on an increasingly large role in the future. An important factor in this will be further improving the safety of nuclear power generation.

Hitachi approaches safety improvement from a wide range of different perspectives based on the know-how we have accumulated through our nuclear energy business. The technology for coating the inner surfaces of piping was developed as part of these initiatives because it reduces the radiation dose to which maintenance workers are subjected.

Treating Inside of Pipes with Hitachi-developed Coating

The nuclear reactor at the heart of a nuclear power plant is filled with uranium fuel and its surrounding cooling water. Because this cooling water reaches temperatures of approximately 280℃, minute quantities of metal elements from structural components dissolve into the water and become radioactive inside the operating reactor. Also because the piping used to circulate the cooling water is in continuous contact with this hot water, the internal surfaces oxidize and progressively build up oxide film. This process captures radioactive metal elements resulting in radiation being emitted outside the pipes. Because allowing this situation to continue would result in workers being exposed to radiation when performing maintenance, a process called chemical decontamination is performed before large-scale maintenance work to eliminate these oxide film. However, even if chemical decontamination is performed thoroughly, oxide film starts to form again when operation restarts and the radiation dose rate in the vicinity of the pipes progressively increases. A technique that has attracted attention as a way of inhibiting the formation of these oxide film is to use a coating of ferrite, a ceramic in which iron oxide is the major component and which is used in applications that include suppressing noise in electronic equipment. However, the coating method used on the several hundreds of square meters of inner surface in power plant piping is very different to that used for the few square centimeters of surface in an electronic device. Also, to minimize radioactive waste as much as possible, it was also necessary to use a reagent capable of being decomposed to apply the coating.

After several years of trial and error, the successful outcome of this development was Hi-F (Hitachi ferrite) coat, a proprietary ferrite coating that can be used to treat the inner surfaces of pipes and which solves these issues.

Approximately 50% Average Reduction in Radiation Dose Rate Rise

To test these results in an actual plant, the coating was applied to two piping systems used for recirculation at Unit 1 of the Shimane Nuclear Power Plant of the Chugoku Electric Power Co., Inc. after first subjecting the pipes to chemical decontamination. After one year in operation, the results showed that the rise in radiation dose rate had been reduced by approximately 50% on average and that, even when the coating was applied at the comparatively low temperature of 90℃, it still worked effectively under actual operating conditions where the temperature is around 280℃.

In the future, we intend to work on combining this technique with the practice of adding zinc to the cooling water to minimize the build-up of radioactive oxide film. Also, although this technique was developed for use in BWRs (boiling water reactors), we also hope to bring its improvement in safety to as many nuclear power plants as possible by undertaking technical development work aimed at extending its application to ABWRs (advanced boiling water reactors) which use different types of piping material.

Makoto Nagase (left), Senior Engineer, Preventive Maintenance Engineering Section, Nuclear Plant Service Department, Hitachi Works, Hitachi-GE Nuclear Energy, Ltd.; Hideyuki Hosokawa (right), Senior Researcher, Chemical System Group, Nuclear Inspection & Maintenance Project, Energy & Environmental Systems Laboratory, Power Systems Company, Hitachi, Ltd.

Commencement of Operation of Variable-speed Pumped-storage Generation System at Omarugawa Power Plant of Kyushu Electric Power Co., Inc.

As measures aimed at curbing global warming become more urgent, the spotlight has been turned on variable-speed pumped-storage generation systems which provide benefits that include smoothing electricity demand and stabilizing the frequency of the electricity supply without emitting CO_2 as part of the generation process. Hitachi has supplied pump-turbines and motor-generators to the variable-speed pumped-storage generation system at Omarugawa Power Plant of Kyushu Electric Power Co., Inc., including the equipment for Unit 4 which commenced operation in July 2007. We intend to continue contributing to delivering stable electricity supplies from renewable energy sources.

From left-rear: Osamu Nagura, Senior Engineer, Power Systems Design Department, Hitachi Works, Power Systems Company; Mikisuke Higuchi, Senior Engineer, Power Electronics Design Department, Power Electronics Systems Division, Information & Control Systems Company. From front-left: Masami Harano, Group Leader and Senior Engineer, Hydroelectric Design Department, Hitachi Works; Masafumi Kakuta, Senior Engineer, Hydroelectric Power Engineering Department, Hydroelectric Power Systems Division, Power Systems Company, Hitachi, Ltd.

Variable-speed Pumped-storage Generation Systems that Contribute to Grid Stability

The Omarugawa Power Plant is a variable-speed pumped-storage hydroelectric power station constructed by Kyushu Electric Power Co., Inc. Omarugawa is a large-scale power plant with four 300-MW class generators that will enter service progressively to provide a total capacity of 1,200 MW, enough to power approximately 400,000 households. The first of these generators to enter service was Unit 4 which commenced commercial operation in July 2007 using a pump-turbine and generator supplied by Hitachi. Unit 1 was the next to enter service in July 2010.

Pumped-storage hydroelectric power generation that works off the difference in head between upper and lower dams not only has the benefit of being able to utilize most of the flow of even relatively small rivers, it can also function like a type of storage battery by converting spare electric power during the night into the potential energy of the water.

The Omarugawa Power Plant uses an advanced version of this concept called a "variable-speed pumped-storage generation system." Whereas turbines on conventional pumped-storage systems are only able to run at a constant speed when reversed to operate as a pump, a variable-speed system is able to vary the turbine speed in pumping mode continuously. That is, the turbine speed can be varied automatically during pumping in response to variations in the frequency on the electricity grid. We believe the system is highly effective because it helps keep the electricity grid stable by automatically performing the fine adjustment of supply and demand balance that in the past required monitoring by a human operator.

Development of Technology to Satisfy Stringent Requirements

For this reason alone, the system is complex and requires technology different to that used in the past. Additional requirements included extending the operating range to improve operating efficiency and shrinking the size of the equipment to reduce construction costs. With a maximum of 701.5 m, the difference in head between the upper and lower dams at the Omarugawa Power Plant is among the highest in the world. We built a series of prototypes to help design a pump-turbine capable of handling both this large head and variable-speed operation. Because the equipment can be made smaller if the turbine operates at higher speeds, we succeeded in creating a system that operates at 600±24 min^{-1} which is faster than any other hydroelectric system of similar capacity. Smaller size was also a consideration for the motor-generator. The generator output is controlled by adjusting the current supplied from the generator's exciter unit to vary the magnetic field strength of the electromagnet. A semiconductor device called a thyristor is an essential component for controlling this current and a critical part of the technical development work involved determining how to shrink the equipment size by reducing the number of thyristors without compromising performance.

Ability to Adapt to Unpredictable Fluctuations in Electricity Supply

As increased use of wind and solar power as a way of reducing CO_2 (carbon dioxide) emissions results in more power sources that vary in output depending on the weather conditions, maintaining the quality of the electricity supply will become an important issue. While the ability to startup and shutdown much more rapidly than other forms of power generation such as thermal or nuclear is one of the characteristics of hydroelectric power, variable-speed pumped-storage generation systems also have the unique feature that variable-speed pump operation allows them to respond promptly to unanticipated fluctuations in supply as well as in demand. Because it is both a form of renewable energy and also has this function for stabilizing the electricity system, it is anticipated that existing pumped-storage power plants in Japan will be upgraded to variable-speed operation and the technology has also started to receive attention overseas. Our aim is to help counter global warming by fostering human resources and maintaining and improving our technical capabilities so that we can respond to the demand for variable-speed pumped-storage generation systems like those described here.

Installation of pump-turbine runner at Omarugawa Power Plant

Palm Jumeirah Transit System Linking Artificial Resort Island to Mainland Dubai

Dubai of the United Arab Emirates in the Middle East attracts tourists from around the world and the Palm Jumeirah Transit System, a monorail that links the Dubai mainland to an artificial resort island, commenced operation in April 2009. This large project was designed based on the concept of a "monorail suitable for a resort area," and Hitachi won orders for the core components of the monorail system which include the monorail cars, electrical conversion system, automatic train supervision system, and power and equipment management system. Hitachi is making a contribution to establishing transport infrastructure around the world based on numerous foreign projects such as this one.

Monorail car in service on Palm Jumeirah Island

First Monorail Project in Middle East

Having enjoyed strong economic growth since the beginning of the 21st century, Dubai of the United Arab Emirates has in recent years focused its attention on the tourism industry with the development of various tourism assets including the construction of an artificial island along with high-rise resort hotels and theme parks. Palm Jumeirah Island can be seen as a symbol of this strategy. The construction of this artificial resort island by the large Dubai developer Nakheel PJSC took on the status of a national project. Hotels, theme parks, condominiums, and villas have already been completed and future plans include the construction of a huge shopping mall and further high-rise buildings.

It was decided from the outset to use a monorail for this transit system which runs for approximately 5.4 km between Palm Jumeirah Island and the mainland because this form of transport offers advantages in terms of practical considerations such as construction cost and schedule while also conveying a sense of luxury that is redolent of the near future. Dubai was the first place in the Middle East to embark on a monorail project and in 2005 Hitachi was awarded the contract to supply most of the core monorail system equipment, including the monorail cars, electrical conversion system, automatic train supervision system, power and equipment management system, and station facilities.

Railcar Design Matched to Concept and Climate

Although the reliability, safety, and other features of our advanced technology for automatic operation, leading-edge automatic train supervision system, and other products obviously played a part in our winning the order, the most important factor was the design of the railcars because of how well the monorail system fitted in with the concept behind the artificial resort island. The design of the railcars was done in collaboration with the Design Division of Hitachi, Ltd. and drew on past experience with vehicles supplied in Japan and elsewhere in the world, and in formulating the design we adopted features aimed at immersing passengers in the feeling of being at a resort, including the use of lounge-style seating and hiding the driver's seat so that passengers can enjoy the view through the front of the railcar. Also, in addition to installing an air conditioning system with a powerful cooling capacity, we also fitted cooling systems to the main drive circuit and auxiliary power supply to prevent faults caused by high temperatures. Other measures we undertook prior to building the monorail system to ensure it could cope with operating in such a hot and humid climate included analyzing the composition of the local sand and testing exposure to it to ensure that fine sand would not adversely effect the monorail cars.

Putting Our High Reliability and Technical Capabilities to Work in Foreign Markets

Because this was the first ever monorail project in Dubai, one of the challenges we faced was that the country had nothing in the nature of railway laws and therefore no clearly defined operational and safety standards for installing the monorail. On the other hand, because the date for commencing service was already set, there was no choice but to establish the rules for the monorail and its associated power and communications in parallel with work on the project itself. Despite this, the system entered service on schedule in April 2009 even though it was subject to numerous changes in its design, specifications, and other parameters along the way.

Our aim is to take advantage of the experience gained in this project to win further orders for monorails in the international market. Factors likely to play an important role in achieving this include compliance with the standards and other rules that apply to monorails in foreign countries, incorporating the latest technology, and establishing the organizational infrastructure to support projects once the order has been received. In doing this, we hope to be able to contribute extensively to establishing transport infrastructure around the world by utilizing the high reliability and technical capabilities that have been built up by Hitachi.

Shinichi Inoue (left), Project Manager, PJTS Project; Nobuhiko Kimijima (right), Monorail Systems Integration Department, Transportation Systems Division, Industrial & Social Infrastructure Systems Company, Hitachi, Ltd.

Compact and Advanced Hitachi 1.3-Mpixel Zoom Chassis Camera

Surveillance cameras are becoming more advanced to meet the needs of society and are being used more widely, not only for crime prevention and other security measures but also for applications such as traffic monitoring. The international market for these cameras is growing as they have become recognized by the public as an extremely effective tool for security and it is anticipated that demand will continue to grow steadily. Hitachi has reacted to the market demand for better clarity of surveillance camera images by developing the advanced and compact 1.3-Mpixel zoom chassis camera.

Takeshi Tahara (left), Camera Design Group, Monitoring Systems Design Department; Yoichi Amari (middle), Manager, Monitoring Systems Department, Security Solution Division, Solution Business Division, Urban Planning and Development Systems Company, Hitachi, Ltd.; Paul Watkins (right), Senior National Sales Manager, Security Solutions Group, Digital Media Division, Hitachi America, Ltd.

International Use of Surveillance Cameras

While London in the UK is widely known as a city with a large number of surveillance cameras, surveillance cameras are also becoming common in countries and regions around the world such as China which has used initiatives such as its safe cities project and events like the Beijing Olympics as an opportunity to introduce more surveillance cameras.

Surveillance cameras that were initially designed to be unobtrusive so that ordinary citizens would not be intimidated have now become a familiar presence and are being positioned in a way that reassures people they are being watched over. Images captured by surveillance cameras can also often be seen on television news broadcasts. In recent times, the cameras have also started to be used in applications other than crime prevention such as in ITSs (intelligent transport systems).

The market requirements for surveillance cameras have also changed in recent years to include demands for better quality using high-resolution megapixel-class images, the ability to transmit the captured images quickly, and the ability to manage the cameras with fewer people. These changes are also evident in the USA where there is a growing need for pervasive security that is locally managed.

In response to these factors, we have developed the compact 1.3-Mpixel zoom chassis camera featuring the latest in image technology which we supply to assembly manufacturers. The camera is designed for ease of integration into a wide range of systems such as security surveillance systems, traffic monitoring systems, and vehicle-mounted video recording systems.

High-performance 1.3-Mpixel CCD and Other Leading-edge Technologies

Featuring a 1.3-Mpixel progressive CCD (charge-coupled device), this zoom chassis camera has HD (high definition) megapixel resolution and also incorporates a digital output interface*1 which outputs the high-quality image signal directly and avoids any degradation that might result from conversion to analog. Because the image remains crisp and clear even when sections are enlarged, features such as vehicle number plates, clothing, and faces can be distinguished easily and the images can provide useful evidence to help track down criminals.

The camera is fitted with an 18X optical zoom lens. Although the F value tends to become darker at high magnifications, the camera has a bright F value of 1.6. This is augmented by a 12X digital zoom*2 function that can further enlarge the image.

Using this zoom lens with its high-precision built-in auto-focus function, the camera can capture images under a wide range of conditions. The Hitachi DSP (digital signal processor) performs exposure, color adjustment, and noise reduction automatically to ensure that appropriate image quality is always maintained. The image captured by the CCD is reproduced with finer detail by the DSP. Because it incorporates these advanced functions required for image capture, one of the key features of the camera recognized by vendors is its powerful sensitivity*3 in low-light conditions such as at night or in dark rooms.

These camera functions are provided in a small camera block. Having the camera use the standard Hitachi size is an important factor for customers because it means that the block size is the same as that of other Hitachi chassis cameras, but incorporating these technologies into this block size was no easy task. This was because the new camera had to confront problems of heat, electromagnetic interference, power consumption, and so on that had already been dealt with for ordinary SD (standard definition) cameras. Also, because the camera needed to support PoE (power over Ethernet*4) for use on a LAN (local area network), it was subject to the technical restriction that it could not use the entire power allowance permitted by PoE. Having cleared these design criteria, the result was a zoom chassis camera able to be used on platforms that are largely the same as those for previous SD cameras.

From Surveillance to Monitoring

With applications for surveillance cameras not limited just to crime prevention and other surveillance purposes, the devices are starting to be used more widely for monitoring purposes such as marketing or management of multi-store operations and, as a consequence, camera systems are being networked to allow remote management and there is growing demand for HD and full HD capabilities. As camera systems are used in more sophisticated ways, they are becoming part of the social infrastructure that helps make our way of life more efficient, convenient, and safe. Cameras are likely to become steadily more important in their role as the initial gateway for this information.

Hitachi will continue to develop digital chassis cameras featuring the latest technology for customers around the globe.

*1 16 bit (Y: 8 bit, C: 8 bit)
*2 Digital zoom can be used in 4:3 aspect ratio output mode.
*3 Minimum illumination of subject: 1.8 lx
*4 See "Trademarks" on page 87.

Involvement in Nuclear Power Plant Construction in Japan

Hitachi is currently working on the construction of two nuclear power plants in Japan and both are proceeding on schedule.
Unit 3 of the Shimane Nuclear Power Plant of The Chugoku Electric Power Co., Inc. is an ABWR (advanced boiling water reactor) with a capacity of 1,373 MW and is due to commence operation in December 2011. Work commenced in December 2005, the reactor pressure vessel was put in place in July 2009, and assembly of the turbine and generator (T-G set) got underway in December. Functional testing of individual systems has already started with the aim of loading the first fuel in the spring of 2011.
The Ohma Nuclear Power Station of Electric Power Development Co., Ltd. is also an ABWR, has a capacity of 1,383 MW, and is due to commence operation in November 2014. Work commenced in May 2008, the geological inspection by the government took place in late October 2009, and work on construction and equipment manufacture is getting underway in earnest during 2010.
Hitachi has been involved in the construction of all ABWR plants in Japan to date and has constructed these nuclear power plants with a high degree of safety and reliability by establishing the optimum construction methodologies to satisfy customer needs, environmental conditions, and other requirements. Hitachi intends to put this technology and experience to work, not only at forthcoming nuclear power plants in Japan, but also in foreign nuclear power plant construction projects.
(Hitachi-GE Nuclear Energy, Ltd.)

Reactor pressure vessel being carried into position by a large crawler crane at Unit 3 of the Shimane Nuclear Power Plant (top) and reactor containment vessel (front-center) being assembled at Ohma Nuclear Power Station (bottom)

Full-scope Training Simulator for Shimane Nuclear Power Station Unit 3

Full-scope training simulator for Shimane Nuclear Power Station Unit 3

Hitachi has installed the full-scope training simulator for Unit 3 of the Shimane Nuclear Power Station which is to be used for training on ABWR (advanced boiling water reactor) operation at the Site Training Center.

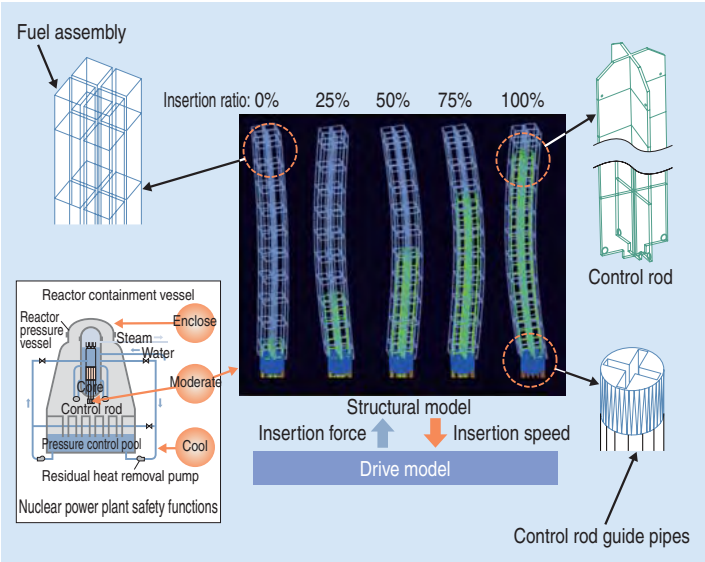
The full-scope training simulator simulates all systems that are subject to operator control required for training, including control panels that mimic the main panels and large display units used at the Unit 3 power plant. The simulator is intended to familiarize operators with the operation of the central control room and allows training exercises to be run that cover training range from standard operating procedures such as startup and shutdown through to responding to accidents. For the simulation models, a model of the dynamic characteristics of the ABWR was developed based on the dynamic characteristics model used in the simulator for the Unit 2 BWR power plant which has a track record of reliable operation, and emulation technology was also adopted to allow the actual control software logic developed and used for the reference plant to run in the simulator without modification. The scope of the simulation was also extended by taking advantage of the characteristics of PCs (personal computers) to display simulated control panels for operation of the upright panels in and out the main control room. These technologies make it possible to duplicate the plant response and interlock operation in a way that faithfully represents the characteristics of Unit 3 and allow more effective simulator training to be provided. The simulator commenced operation in September of 2009 and it will continue to contribute to improving the essential skills of the operators in the future.

(Hitachi-GE Nuclear Energy, Ltd.)

Technology for Analyzing Seismic Scrammability

Nuclear power plants in earthquake-prone Japan incorporate a safety feature called "seismic scrammability" that automatically shuts down the reactor by inserting the control rods into the reactor core in the event of an earthquake larger than a designated magnitude being detected. In the past, the soundness of the seismic scrammability function was verified by conducting vibration testing using full-size equipment including the control rods and fuel assemblies. The newly developed technology for analyzing the ability to insert the control rods in the event of an earthquake provides a realistic means of testing insertion under conditions that are difficult to replicate in a mock-up test, including the conditions inside the reactor when it is operating and the greater fuel response displacement determined by recent revisions in the anticipated strength of earthquake vibrations.

The analysis technology consists of a structural model that calculates the vibration and contact behavior of the control rods, fuel assemblies, and other components and a drive model that calculates the drive force produced by the control rod drive mechanism that raises the control rods. In addition to calculating how the fuel assemblies vibrate underwater inside the actual reactor, the structural model also calculates the force of contact between contacting surfaces defined in three dimensions. The drive model determines the drive force by calculating the hydraulic pressure based on the control rod insertion speed obtained from the structural model. By coupling these models together and using an iterative process to calculate how they interact, the technology is able to simulate the complex insertion behavior.



Model for analyzing seismic scrammability and insertion behavior

This technology will contribute to improving further the earthquake safety of nuclear power plants.

(Hitachi-GE Nuclear Energy, Ltd.)

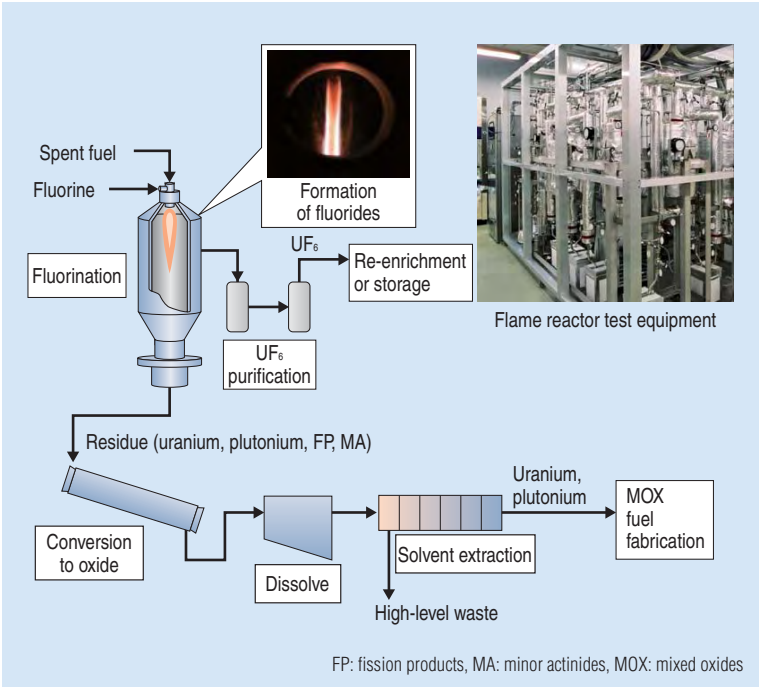
Development of Advanced Reprocessing Technology

Hitachi is working on the development of a reprocessing technology that combines the fluoride volatility process and solvent extraction process to provide a reprocessing technology with good economics suitable for the future transition period from light water reactors to fast breeder reactors.

The technology utilizes the fluoride process whereby a flame furnace is used to separate out the bulk of the uranium that makes up 96% of the spent fuel from a light water reactor by volatizing it in the form of UF_6 (uranium hexafluoride) so that it can be recovered and reused as high-purity UF_6. Most of the elements other than uranium are left behind as a solid fluoride residue from which uranium and plutonium compounds can be extracted with a high degree of purity using the solvent extraction process. Ongoing research and development of this technology has been undertaken in cooperation with research institutions in Japan and abroad and with public-funded research for the Ministry of Economy, Trade and Industry, Ministry of Education, Culture, Sports, Science and Technology, and the practicality of the technology has been confirmed by methods that include flame reactor testing using uranium and proof-of-principle testing using actual spent fuel.

Hitachi is also involved in research and development of new fuel cycle system concept suitable for the transition period and is working on research and development aimed at realizing reprocessing technology that can respond flexibly to the future needs of the nuclear fuel cycle.

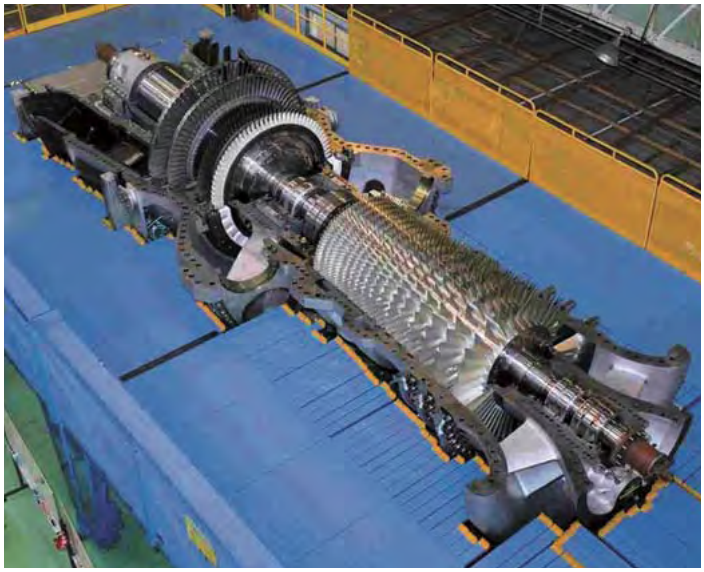
(Hitachi-GE Nuclear Energy, Ltd.)



Process flow and test system for FLUOREX reprocessing method

Use of Highly Efficient Mid-range Gas Turbines to Improve Efficiency at Existing Combined-cycle Plants

For the replacement market at combined-cycle plants that have reached the age of around 20 years since their initial construction, Hitachi has developed a highly efficient 80-MW class mid-range gas turbine (the H-80) and has undertaken testing at the company's test facility to verify its performance and reliability including startup and acceleration testing, no-load testing, and load testing at 100% output.



H-80 highly efficient 80-MW class mid-range gas turbine

The development of the new H-80 80-MW class gas turbine was based on the existing H-25 gas turbine of which more than 130 units have already been delivered. Replacement projects at combined-cycle plants can achieve efficiency improvements of 8% (relative) or more by replacing the gas turbine only and continuing to use the existing steam turbines, boilers, and other equipment. To satisfy the requirements of this market, the H-80 has roughly the same size as existing units and, to ensure compatibility with different boilers, it has been designed with the flexibility to cope with a wide range of exhaust gas temperatures. Also, a low-NO_x (nitrogen oxide) combustor is used to reduce the impact on the environment.

The first H-80 gas turbine was installed at Unit 1 of the Shin-Oita Power Station of Kyushu Electric Power Co., Inc. and started commercial operation in January 2010.

Completion of New Unit 2 of Isogo Thermal Power Station of Electric Power Development Co., Ltd. (J-Power)

New Unit 2 of the Isogo Thermal Power Station of Electric Power Development Co., Ltd. (J-Power) commenced operation in July 2009.

Isogo Thermal Power Station is a coal-fired ultra-supercritical-pressure power plant with a steam turbine generation set supplied by Hitachi. The turbine plant was designed to have a world-class level of efficiency and this was achieved without incident. This leading-edge thermal power plant boasts of being among the most efficient coal-fired ultra-supercritical pressure power plants in the world, which helps reduce CO_2 (carbon dioxide) emissions significantly.

An important feature of the power plant is its ability to use both pure pressure control operation and throttled pressure control operation. For pure pressure control operation, the CVs (control valves) are fully open at low load so that any increase in steam flow translates into an increase in steam pressure. Unlike nozzle governing used in the past, this allows the system to maintain high efficiency under rated operating conditions without CV throttling. It also allows the number of CVs to be reduced from four to two. Throttled pressure control operation provides a governor-free function that throttles the CVs to raise the pressure under rated operating conditions compared to that using pure pressure control.

Steam turbine at Isogo Thermal Power Station of Electric Power Development Co., Ltd. (J-Power)

To improve efficiency, the unit also uses 48-inch (approximately 1,219 mm) turbine blades (one of the biggest in the world) for the final-stage turbine which operates at 3,000 rpm at the steam conditions for rated output (using pure pressure control), which are a main steam pressure of 25.0 MPa(g), a steam temperature of 600℃, and a reheat steam temperature of 620℃.

Commencement of Operation of Units 3 and 4 at Korea South-east Power Co., Ltd.'s Yeongheung Thermal Power Plant

Steam turbine generator at Yeongheung Thermal Power Plant of Korea South-east Power Co., Ltd.

The steam turbine generators supplied to Units 3 and 4 at the Yeongheung Thermal Power Plant constructed at Ongjin-gun in Incheon Metropolitan City (in the northeast of South Korea) by Korea South-east Power Co., Ltd., a spin-off of Korea Electric Power Corporation, commenced operation in June and December respectively of 2008.

These units are large coal-fired thermal power plants with an output of 870 MW, the largest of any thermal power plant in South Korea, and being located close to Seoul, they require a high level of technical capabilities in the field of electricity generation efficiency using world-leading supercritical technology to ensure the security of supply needed for a large city and to reduce CO_2 (carbon dioxide).

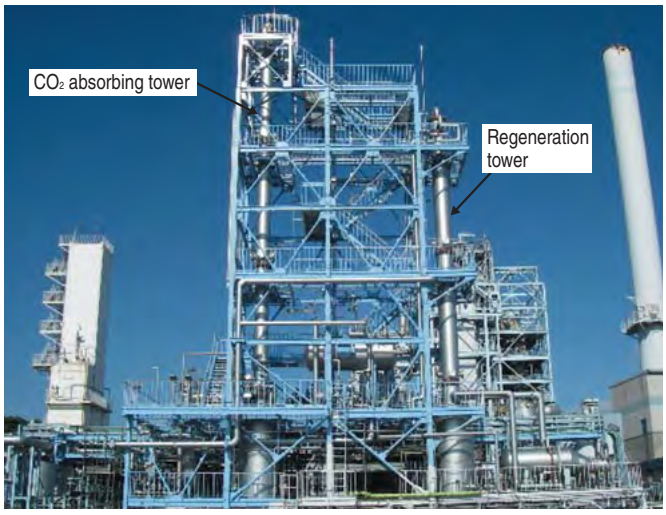
An international tender was called based on these requirements and the contract awarded based on a favorable evaluation of the technical capabilities and other features of Hitachi's large steam turbine generators and their track record in the world.

In addition to all of the equipment supplied for the project being delivered on time to coordinate with the power plant construction schedule, the customer was also highly impressed by the excellent quality and performance achieved by the project.

With further upgrades to this power plant along with the construction of additional large coal-fired thermal power plants by other power companies in South Korea being planned, Hitachi is working actively to win further orders by building on this contract and the success of the project.

Development of CO_2 Recovery Technology for Gasified Coal Plants

New Energy and Industrial Technology Development Organization (NEDO) and Electric Power Development Co., Ltd. are working on the Multi-Purpose Coal Gasification Technology Development [EAGLE (coal energy application for gas, liquid, and electricity)] Project to develop multi-purpose coal gas production technology with the aims of improving the efficiency of coal use and moving toward zero emissions. Hitachi supplied a set of test facilities and is providing support for the experimental work.



CO_2 separation and recovery equipment

EAGLE is a pilot coal gasification plant with a processing capacity of 150 t of coal per day. Step 1 from fiscal 2002 until 2006 successfully achieved its development objectives which involved conducting experiments aimed at developing a coal gasification furnace with oxygen injection and establishing gas refining technologies.

Step 2 which looks at how to achieve zero emissions commenced in April 2007 and has involved research and development into the separation and recovery of CO_2 (carbon dioxide) from coal gas.

Test operation that continued up until July 2009 demonstrated the ability to recover 1,000 kg/h of CO_2 from 1,000 m^3N/h of coal gas with a recovery ratio of 90% or better and an impurity ratio in the recovered CO_2 of 1% or less. Because CO_2 recovery from coal gas is performed when the CO_2 concentration is high after CO (carbon monoxide) shift and with the gas pressurized to 2.5 MPa, features of the process include being able to make the equipment more compact and a reduction in the associated energy losses. This is the first time that the separation and recovery of CO_2 from coal gas has been demonstrated anywhere in the world and further proof-of-principle testing of CO_2 recovery continues.

Systems for Thermal Power Plants that Utilize Latest Control Technology and IT

The following developments have arisen from the growing demand in recent years for safety, security, and convenience as well as environmental measures in the operation of thermal power plants.

[Environmental measures]

(1) Energy-efficient inverter system [energy savings, CO_2 (carbon dioxide) reduction]

The adoption of high-voltage direct inverters to provide variable-speed operation of the large electric motors used in thermal power plants reduces losses, particularly at low load, and delivers significant energy savings.

(2) Control systems that reduce environmental impact [reduction in NO*x* (nitrogen oxide) and CO (carbon monoxide)]

The volume of NO*x* and CO emitted by thermal power plants can be reduced by using optimum control technology to optimize boiler combustion.

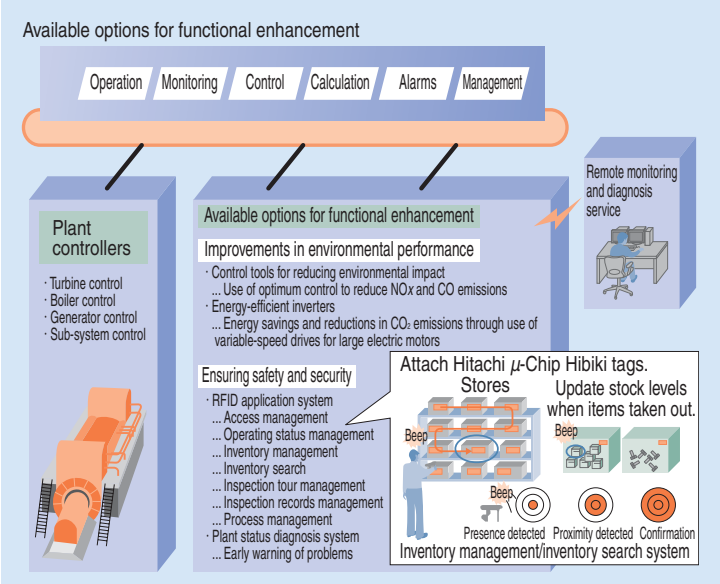
[Safety, security, and convenience]

(1) RFID (radio-frequency identification) application system (improvement in efficiency of periodic maintenance, rationalization of parts management, transfer of know-how)

This system uses RFID tags and IT (information technology) to support maintenance administration and can be used in power plants to rationalize working practices and pass on know-how.

(2) Plant status diagnosis system (early detection of problems, improvement in utilization)

This new plant status diagnosis system can collect process data on-line and determine the status of the plant automatically without requiring complex settings to be specified by users.



Systems for thermal power plants that utilize latest control technology and IT

New RoHS-compliant and Environmentally Conscious Digital Speed Regulator for Water Turbines

Item	Specification
Controller	32-bit single-board controller
Control unit (E/M converter)	Linear force motor
Performance	Equivalent to class X in Vol. 42, Issue 2 of Electric Technology Research, IEC 61000, 255 equivalent
Operating pressure	1.4—7.0 MPa
Power supply voltage	DC, AC 100 V, 200 V

E/M: electric-mechanical converter, IEC: International Electrotechnical Commission, DC: direct current, AC: alternating current

Control panel (top left), control unit (top right), and specifications (bottom) of new digital speed regulator

Hitachi has developed and released a new digital speed regulator for water turbines and pump-turbines.

By seeking to comply with the RoHS (Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) directive that has been effective in preventing the spread of environmentally harmful substances, the new digital speed regulator makes it possible to supply products that take greater account of the environment both in Japan and elsewhere. Although the controller used in previous digital speed regulators supported use in a redundant configuration, the new model also has dual speed regulator actuators (mechanical control units) to improve reliability by giving the speed regulator a completely redundant configuration. By revising the specifications of each component in the speed regulator controller, an MTBF (mean time between failures) of 260,000 hours has been achieved (approximately five times that of the controller on the previous model).

These improvements increased reliability and made it possible to build a digital speed regulator that is compatible with the objective of zero downtime.

The first unit is to be supplied to the Tangga hydroelectric power station of PT. Indonesia Asahan Aluminium. The new model will also become the standard digital speed regulator for supply in Japan and elsewhere from 2009 onwards.

New Runner for Adjustable Speed Operation of 310-MW Pump-turbine at Okutataragi Power Station

The increasing volume of electricity generated by highly variable renewable energy sources such as wind and solar power has a potential to cause fluctuations in the electricity supply that cannot be ignored. Pumped-storage hydroelectric generation plants capable of adjustable speed operation have attracted attention in recent years as a type of system that can absorb these variations and stabilize the electricity grid.

If existing pumped-storage hydroelectric generation plants that operate at a fixed speed are converted to adjustable speed operation, it becomes possible to respond rapidly to the requirements of the electricity grid by varying the input during pumping as well as the output during generation and this facilitates the effective use of highly variable renewable energy sources.

As part of an overhaul of Unit 1 at the Okutataragi Power Station of The Kansai Electric Power Co., Inc., Hitachi is currently replacing the turbine runner and will upgrade this key component of the power plant to an adjustable speed pump-turbine.

The new runner is a splitter-blade pump-turbine runner that alternates two different types of vane with different lengths and was designed using the latest technology utilizing CFD (computational fluid dynamics). Also, the runner is produced in two parts, the same as the existing runner, to satisfy transportation constraints.

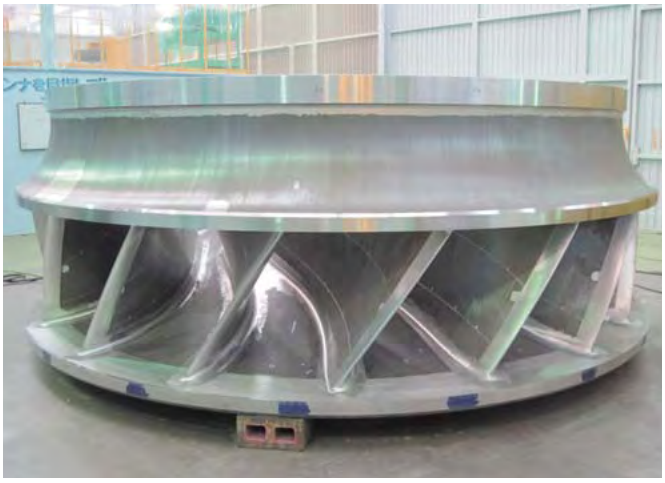
Splitter-blade pump-turbine runner under construction for Okutataragi Power Station of The Kansai Electric Power Co., Inc.

Large-scale Refurbishment of 128-MW Francis Turbine at Bhakra Power Plant in India

The rapid economic growth in India has created a situation in which electricity demand is outpacing supply. This has made increasing generation capacity a high priority and, in addition to building large new power plants, a lot of work is going into uprating the output of existing power plants.

As the water turbines supplied by Hitachi for the Bhakra Power Plant (the generators were made in the UK) are now aging, having commenced operation about 50 years ago in 1959, a large-scale refurbishment of the five Francis turbines is to be carried out over the three years from 2010 to 2012.

By updating to optimally designed forward-swept vane runners (shaped so that the band end of the vane inlet is advanced in the direction of rotation relative to the crown end) and guide vanes, the refurbishment will both improve the turbine efficiency and upgrade the output to 16,633 kW per turbine giving the plant a total output of 83,165 kW, further improving the reduction in emissions of greenhouse gases (CO_2). Also, whereas the current runners have undergone repeated repairs for cavitation erosion of the suction surface on the inlet side of the turbine, the new runners have significantly improved the extent of cavitation bubble formation at the corresponding position which is anticipated to lengthen the time between repairs and extend the life of the runners.



New runner under manufacturing at factory (forward-swept vane runner, upside-down condition)

[Turbine specifications after refurbishment]
Effective head: 134 m (rated)
Turbine output: 128 MW (maximum)
Turbine speed: 166.7 min^{-1} (rated)

Overhaul of Two 144-MW Pump-turbines and Motor-generators for Mazegawa No. 1 Power Plant of Chubu Electric Power Co., Inc.

Photo of a rotating servo motor being reassembled in the factory after refurbishment

The 144-MW diagonal-flow pump-turbines and motor-generators at Mazegawa No. 1 Power Plant feature a very high head and the highest capacity of any single unit in the world. After more than 30 years of reliable operation since they were commissioned in 1976, an overhaul of the two units is now nearing completion with work on Unit 2 having commenced in April 2008 and flow testing of Unit 1 scheduled for completion in July 2010.

These diagonal-flow pump-turbines have a complex and detailed structure that can open and close the runner vanes using a link lever controlled by rotating servo motors mounted inside the main shaft. The overhaul was undertaken in consultation with the customer because it involved proposing the best way to make repairs, including the possible remanufacture of some parts, based on the extent of wear found on each component.

A feature of the pumped-storage generation system at Mazegawa No. 1 Power Plant which uses diagonal-flow pump-turbines is that, when operating in pumping mode, it can adjust the pumping volume and electric power input by adjusting how far to open the runner vanes and guide vanes, and it is anticipated that this overhaul will allow the system to continue contributing to adjusting the frequency, load, and other parameters of the electricity grid.

Scrap and Build of 10,900-kW Vertical-axis Francis Turbine and Generator at Unit 1 of Minochi Power Plant

The Unit 1 turbine and generator at the Minochi Power Plant of The Tokyo Electric Power Co., Inc. was upgraded reusing some existing parts and restarted operation in August 2009.
The power plant entered service in 1943 and the current upgrade was to Unit 1 which started operation in 1954.
[Key features]
(1) The water supply for water cooling system was eliminated by adopting self-cooling turbine guide bearings and air-cooled generator guide bearings.
(2) Along with adopting the above bearings, the equipment configuration was simplified and maintenance improved by using bearings with self-contained lubrication which eliminated the need for a lubricating-oil-circulation system.
(3) An electrically operated speed regulator and brake were adopted that do not require hydraulics.
(4) Together with the upgrades made previously to Units 3 (1998) and 2 (1999), the current upgrade eliminated any requirement for water supply and hydraulics at the power plant.
Hitachi is helping improve maintenance and contributing to reducing risks to the environment from oil leaks through scrap and build projects for existing hydroelectric power plants that eliminate the need for auxiliary systems such as those used for water supply, lubrication, and hydraulics.


Turbine casing being assembled at factory

Commencement of Operation of 400-kW Power Conditioner (Inverter) for Large Photovoltaic Power Generation System

Outdoor cubicles for the 400-kW power conditioners installed at Hokuto

Hitachi has started operation of 400-kW power conditioners (inverters) for large-scale photovoltaic power generation systems for demonstrative research. Development of the power conditioner was commissioned by NTT FACILITIES, INC. for a Japanese national project called "Verification of Grid Stabilization with Large-scale PV (Photovoltaic) Power Generation Systems—Hokuto Site" which is being run by the New Energy and Industrial Technology Development Organization (NEDO).
Power conditioner is a type of inverter used for DC/AC (direct current/alternating current) power conversion to connect DC electric power generated by photovoltaic panels to AC electric power system. The power conditioner has a larger-than-normal capacity of 400 kW to achieve greater economy. Hitachi improved the quality of the generated power by adopting an AC 400-V power distribution and circuit structure that operates with high efficiency during periods of low power generation.
The power conditioner incorporates newly developed functions for stabilizing the electric power system. These include AC power system voltage stabilizing, FRT (fault ride through), and harmonic current suppression which were developed to reduce the effects caused by large PV generation systems.
The demonstrative research is ongoing for five years from 2006 at the Hokuto Site in the Yamanashi region of Japan. A 1.2-MW electric power generation system including three 400-kW power conditioners was added in 2009, giving the site a total photovoltaic power generation capacity of 1.84 MW.

On-line TSC System for Chubu Electric Power Co., Inc.

Chubu Electric Power Co., Inc. has operated an online TSC (transient stability control) system since 1995 to prevent major power blackout caused by acceleration of generators when a fault occurs in the electricity grid. The system has now been upgraded with newly developed functions based on this operating experience.

Online TSC system for Chubu Electric Power Co., Inc.

[Key features]

(1) In addition to cost reductions achieved by integrating with the existing systems, adoption of the new ranking function allowed the computer hardware to be downsized.

(2) To respond accurately to changing conditions in the electricity system, the calculation interval was shortened from 5 minutes to 30 seconds. To make this possible, a ranking function which ranks likely fault locations in order of how critical they are to the system was developed. It improves the accuracy of stability control by prioritizing the calculation for likely fault locations that are subject to severe stability conditions.

(3) Blade servers designed for control applications were selected for the hardware to achieve both reliability and high performance.

It is expected that bringing this system into service will contribute to the future stable and economic operation of the electricity grid.

(Commencement of operation: May 2009)

Replacement for No. 1 Frequency Converter at Shin-shinano Substation of The Tokyo Electric Power Co., Inc.

Work on replacing the No. 1 FC (frequency converter) at the Shin-shinano substation of The Tokyo Electric Power Co., Inc. completed in June 2009 and the unit started commercial operation. The new No. 1 FC was a replacement for the old unit which entered service in 1977 and was now aging.

The FC is a system for interconnecting between the eastern area (50 Hz) and the western area (60 Hz) of Japan. In addition to providing a more flexible electric power interconnection than the old No. 1 FC, the new unit also helps to improve the stability and reliability of the interconnected AC (alternate current) power system by providing emergency power flow control. The conversion capacity is 300 MW which combined with the No. 2 FC provides the ability to transfer up to 600 MW of electric power.

60-Hz-side thyristor valves for No. 1 FC

Hitachi's scope of work in the replacement project was system study and supply of the equipment for the 60-Hz side of the FC and this was achieved by utilizing the experience and skills that Hitachi has honed in the field of power electronics technology for electric power conversion systems. The work consisted of a design process and a manufacturing process based on approximately two years of rigorous testing and evaluation to ensure reliability, and then not only the main thyristor valves [125-kV DC (direct current), 2,400 A] but also the conversion transformers, control and protection systems, valve arresters, and DC voltage divider were installed in July 2008. After equipment and sub-system testing on site, the unit was subjected to four months of the system tests with the actual AC electric power grids from March to June 2009, after which the new No. 1 FC entered commercial service.

Wastewater Reuse System Using Ozone Micro-bubbles

Reuse of the water produced by sewage treatment is needed to achieve recycling of valuable water resources. In particular, ozone-based oxidation treatment is effective for the sterilization, deodorizing, and decoloration essential for recreational water use where high quality is demanded. Hitachi has released and started taking orders for a new sewage treatment system based on ozone treatment that utilizes the properties of tiny micro-bubbles with a diameter of only 50 µm.

Ozone micro-bubble wastewater reuse system (daily capacity: 600 m^3)

Ozone micro-bubbles are highly soluble and highly reactive, and can achieve a higher level of water treatment efficiency than past ozone treatment systems with bubbles in the millimeter range. The new system has succeeded in making the ozone reaction tank smaller (height: 1.3 m) while reducing ozone usage by using a specially designed nozzle and bubble generation loop to reduce the pressure for forming the micro-bubbles while increasing the number of bubbles produced. This allows the system to produce recycled water that meets the standards for recreational water (E. coli: undetectable levels, color: 10 mg/l or less, turbidity: 2 mg/l or less, etc.) using less ozone than previous systems with millimeter-sized bubbles.

Hitachi is contributing to a recycling-based society by working to commercialize products that help recycle sewage and reduce the impact on the environment, not only for Japan as in the past, but also for China where water shortages are becoming severe.

Solar RO Film for Abu Dhabi—Desalination Plant that Helps Protect Endangered Species—

The Arabian oryx, a member of the bovine family, lives in desert regions and is now at risk of extinction with a population that continues to fall year by year due over-exploitation for various reasons including the animals' meat and also their horns which are used in crafts. The water supply equipment ordered by this contract is to be installed in the Emirate of Abu Dhabi of the United Arab Emirates with the aim of protecting the oryx along with gazelle and other species. A total of 15 units will be installed along the border with the Emirate of Dubai. As the water for the project is sourced from wells and is contaminated with salt, it will be processed through desalination equipment using RO (reverse osmosis) film. The desalinated water will then be supplied via an aqueduct to water holes for the oryx and other animals living in the wild. The equipment takes account of the local environment and uses a solar electricity supply (independent generation system with a total generating capacity per unit of 45 kW). The processing capacity of the RO film equipment is 4m^3/h at each site and the system only operates during daylight. Although storage batteries are fitted to ensure steady operation, the system does not operate at night. As oryx are nocturnal and stand with their feet in the water when they drink, the water is provided in shallow ponds rather than troughs. A remote monitoring system based on GPRS (general packet radio system) is also provided so that the status of the 15 sites which are scattered around a large region of desert can be managed efficiently.

Solar RO project for Environment Agency of Abu Dhabi

The water supply system is designed to be friendly to the environment and to suit installation on isolated islands and other remote locations where it is difficult to provide electricity, and the same solar technology is considered suitable for use in effluent treatment systems such as MBRs (membrane bioreactors).

(Hitachi Plant Technologies, Ltd.)

Soil Decontamination Using Indirect Thermal Desorption

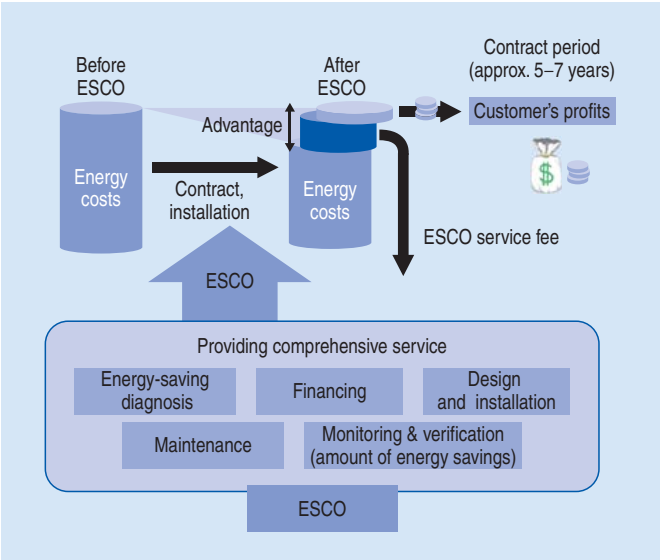
The technology of indirect thermal desorption was introduced in 2007 as a means of dealing with contamination by PCBs (polychlorinated biphenyl) and dioxins, a market that is anticipated to grow in the future. The technology allows contaminated soil at a site to be cleaned up using a mobile indirect thermal desorption system that can be transported and set up at the site. To prevent the soil from being scattered outside the site, a tent is erected to cover the process of digging up the contaminated soil. The excavated soil is placed in special-purpose containers and then transported to the decontamination yard where it is indirectly heated to approximately 400 to 600℃ in the indirect thermal desorption system to volatize and separate out the contaminants. The separated contaminants collected by the process are condensed to a volume only 1% that of the inserted soil. The decontaminated soil is first analyzed to confirm its safety and then restored by taking it back to the location from which it was excavated. The indirect thermal desorption system can operate continuously 24 hours a day and has a maximum capacity of 50 m^3 per day. Having introduced technology that can deal with PCB and dioxin contaminants, Hitachi aims in the future to broaden the use of this system and take a more active approach to its marketing in order to expand sales.

Indirect thermal desorption system

(Hitachi Plant Technologies, Ltd.)

Hitachi Energy Solution for Reducing GHG Emissions in Southeast Asia

Under the Copenhagen Accord, COP15 (fifteenth session of the Conference of the Parties), almost all developed countries and many newly developing countries are required to set targets for reducing emissions of GHG (greenhouse gases), particularly CO_2 (carbon dioxide). This means that reducing CO_2 emissions will become more and more important in the near future. Hitachi's energy solution service provides comprehensive support for reducing CO_2 emissions and saving energy efficiently by analyzing the total energy savings available in factories. Hitachi has utilized this energy solution service in 12 projects to date, all of which have been in Southeast Asia (Philippines, Thailand, Singapore, and Indonesia).



ESCO service concept

The shared ESCO*1 (Energy Service Company) service requires no initial investment by the customer and guarantees that long-term reductions in energy use can be achieved after the systems are installed and energy-saving modifications completed. The service also includes financing, maintenance, and verification. ESCO recoups its investment from a service fee that is less than the energy cost-savings.

Hitachi has seven ESCO contracts in Southeast Asia. ESCO services are provided to the customer in the form of highly efficient air conditioning systems and waste heat recovery systems. The total reduction in CO_2 emissions achieved by these seven ESCO services amounts to 13,700 t/year*2.

Hitachi intends to utilize all of its available technologies in implementing these ESCO services throughout Southeast Asia to obtain a triple-win for the global environment, the customer, and Hitachi.

*1 Shared ESCO: An arrangement whereby ESCO owns the utility systems

*2 Based on planned contract value [for orders received during 2009 or earlier and calculated from CO_2 emission factors based on the International Energy Agency (IEA) data]

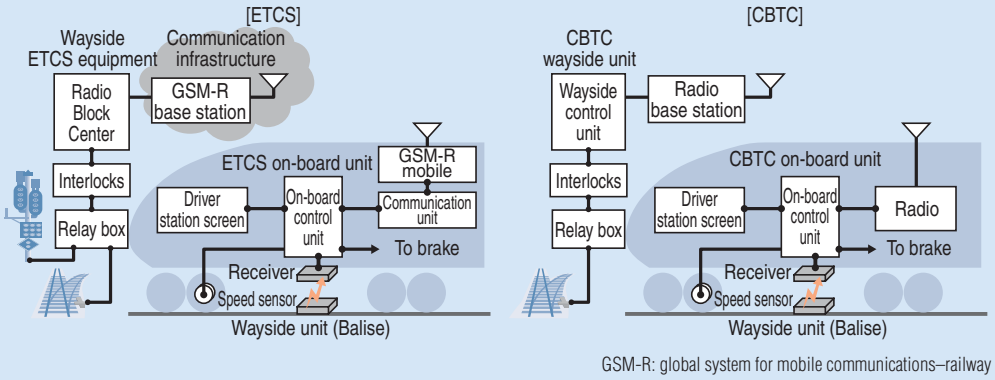
Train Control Systems for Global Markets

The world's railway systems can be broadly divided into high-speed, long-distance intercity services and suburban commuter services (including subways and monorails). For intercity services, use of the ETCS (European Train Control System) standard is becoming increasingly widespread as a means of managing traffic and increasing traffic volume. A notable trend for commuter services is the adoption of CBTC (communication-based train control) systems for the purpose of shortening the interval between trains.

Hitachi has been developing train control systems based on the highly reliable signaling technology it has built up from projects in Japan and has won orders for both intercity and commuter services. These advanced train control systems use bi-directional communications to exchange data between wayside and on-board systems and are based on the concept of train-based control whereby units mounted in the trains determine the train location and perform speed control.

For the future, Hitachi intends to continue putting its extensive experience to work in developing train control systems with an international outlook in order to strengthen further its business operations in the international market for railway signaling, a market that is expected to grow.

Project	Country (customer)	Type of signaling system	Summary
Train control system for Guangzhou-Shenzhen-Hong Kong Passenger Dedicated Line	China (Guangzhou-Shenzhen-Hong Kong Passenger Dedicated Line Co. Ltd.)	ETCS Level 2	·First order for an ETCS system received by a Japanese supplier ·Line length: 103 km (from Guangzhou to Shenzhen) ·Uses mobile phone radio communications (GSM-R)
Development of signaling system complying with ETCS standard	UK (Network Rail)	ETCS Level 2	·Collaborate with Network Rail. ·Uses mobile phone radio communications (GSM-R)
Train control system for No. 3 Line of the Chongqing Rail Transportation Company	China (Chongqing Rail Transportation Company)	CBTC (air radio)	·First order for an air-radio-based train control equipment received by a Japanese supplier ·Line length: 20 km, No. of stations: 18, No. of trainsets: 19 ·Uses space-wave radio communications
Train control system for No. 3 line of Daegu urban railroad	South Korea (Daegu Metropolitan City Urban Railroad Construction Headquarters)	Digital loop	·Line length: 24 km, No. of stations: 30 ·Uses digital-loop bi-directional communication system using a loop line installed on the rail beams



GSM-R: global system for mobile communications–railway

Train control system projects undertaken by Hitachi (top) and overview of ETCS and CBTC systems (bottom)

Traffic Management System for Osaka Loop Line and Yamatoji Line of West Japan Railway Company

The traffic management system for the urban lines of the West Japan Railway Company was initially installed for the Hanwa Line in 1993 and then progressively extended to cover the JR (Japan Railway) Kyoto and Kobe Lines, Hokuriku Line, Biwako Line, Ako Line, and Osaka Higashi Line. The system has now been extended to the Osaka Loop Line and Yamatoji Line where it entered use in October 2009.

Large traffic display panel and stop sign display unit (top right) at Shin-Osaka General Control Center

The new system includes stop sign display units installed at each station to help recover quickly when trains get behind schedule. These convey instructions such as "stop," "prepare," and "notify" from the controllers to the crew on the train to help prevent trains having to wait between stations and to reduce the volume of wireless communications during times of congestion. Also, train and signaling information is exchanged between the systems for each line to handle the case when trains transfer from other lines such as the JR Kyoto Line or Hanwa Line.

The system will be expanded to cover more lines in the future with installation for the JR Takarazuka Line, JR Tozai Line, and Gakkentoshi Line already planned.

New E5 Series High-speed Shinkansen (Prototype)

East Japan Railway Company has manufactured and is currently undertaking operating trials of a prototype of the new high-speed Shinkansen (bullet train) (E5 Series) which will be introduced in time for the opening of Shin-Aomori Station on the Tohoku Shinkansen Line in December 2010.

The E5 Series reaches maximum speed in commercial operation of 300 km/h in March 2011 and 320 km/h in March 2013. The premium-brand GranClass Car is introduced to provide a world-class level of service. These cars have been laid out with attention to detail in every respect including internal design, quietness, and dedicated seat lighting to create private spaces that offer a level of quality and comfort never before seen in existing train, with the objective of providing passengers with a time when they can feel relaxed and peaceful with services that include being waited on by a dedicated attendant.

E5 Series high-speed Shinkansen

Upgrade to Traction Control Equipment for UK Class 465

Hitachi has received an order to supply and install new traction control equipment and maintain the equipment after delivery as part of an upgrade of the traction control units in UK Class 465 trains manufactured in the 1990s. The aims of the upgrade include preventing failures in rolling stock and reducing maintenance costs, and the project involves the replacement of the traction control units produced by another manufacturer in 97 trains.

The upgrade has improved train reliability and achieved better energy-efficiency by replacing the traction circuits with inverters that use low-loss IGBTs (insulated gate bipolar transistors). Trains fitted with the new inverters started entering service progressively from March 2009. One of the reasons for winning the order was the favorable evaluation of the operating trials of the new inverters that Hitachi conducted in the UK prior to this project. Hitachi aims to continue contributing to the development of railway systems in the UK, the birthplace of the rail industry.

UK Class 465 train and traction control unit (top right)

Electrical Systems for Suburban Commuter Trains in Sydney, Australia

Concept drawing of new rolling stock for Sydney suburban commuter trains
(Supplied by Reliance Rail Pty Ltd)

The replacement of existing rolling stock used on Sydney's suburban commuter rail services operated by Rail Corporation New South Wales (RailCorp) in New South Wales, Australia, will see Hitachi supplying 78 sets totaling 626 cars (including two spare cars), all with a double-decker configuration, between 2010 and 2013.

During the design of the main motors, traction inverters, and other electrical equipment to be used on the trains, particular attention was paid to compatibility with the existing track-side signaling system and to achieving a high level of adhesion control characteristics with the aim of ensuring good safety and reliability.

All factory testing was completed by April 2009 and the series of shipments have now commenced, starting with the equipment for the pre-production train set and the first train set. Fitting and complete car testing work is also progressing in earnest in Australia with the target of having the first trainset enter service in the latter half of 2010.

Electrical Systems for No. 6 Subway Line in Shanghai China

Yongji Xinshisu Electric Equipment Co., Ltd., Hitachi Yonge Electric Equipment (Xi'an) Co., Ltd., and Hitachi, Ltd. are working together to supply an electric traction system that includes traction motors and traction inverters, an auxiliary power supply system that includes stationary inverters, and a train monitoring and control system with a command transmission function to the No. 6 Subway Line in Shanghai, China (total length 33.5 km, 28 stations).

The No. 6 Subway Line commenced operation in December 2007 and is one of the lines that pass through the Pudong Development Zone, the venue for Expo 2010 Shanghai China. Although the line had suffered from an ongoing shortage of trains due to the rapid increase in the number of passengers, new cars fitted with Hitachi electric systems have been added to relieve congestion.

The new cars have entered service without incident and they are being kept busy providing the people of Shanghai with a means of getting about.


New rolling stock for No. 6 Subway Line in Shanghai undergoing testing at a rolling stock manufacturer in China

Ultra-high-speed Elevator Supplied to New Countryside Building in the Sky

Hitachi will supply 33 transport systems consisting of six escalators and 27 elevators, including nine ultra-high-speed elevators capable of speeds of 300 m/min or more, to the large multi-purpose 328 m high New Countryside Building in the Sky (two underground floors, 72 above-ground floors) under construction in Huaxi, a village located in Jiangyin City in Jiangsu province that has been designated as a model for agricultural community development in China.

The systems are anticipated to provide an important means of travel around the building and include three shuttle elevators for the observation deck that have a speed of 600 m/min and a capacity of 1,600 kg and two shuttle elevators for the rotating restaurant that have a speed of 480 m/min and a capacity of 1,600 kg.

This will be the first time Hitachi supplies ultra-high-speed elevators with a speed of 600 m/min to the Chinese market and the systems incorporate the following technologies to ensure a comfortable ride.

(1) Active guide units are fitted to reduce lateral vibration of the elevator car. These units consist of three compact and lightweight actuators together with sensors and a controller. They reduce lateral vibration by controlling the force applied by the guide roller units based on detection of bends in the rail of the order of several tenths of a millimeter.

Concept drawing of the completed New Countryside Building in the Sky

(2) Wind noise while the car is in motion is reduced to achieve a quiet ride for passengers inside the elevator car through measures that include using sound proofing capsules that minimize air turbulence in the elevator shaft and a double-skinned car structure that improves noise-proofing.

(3) Because the 306.3-m height of the elevator shaft results in greater rope stretching, advanced speed and position control is needed to automatically adjust the stop position and car floor level. For this reason, a position detector that uses three optical axis sensors is fitted on the car and a highly accurate and responsive floor alignment control circuit is used to improve the accuracy with which the elevator halts at floor level.

(4) A unit that displays the elevator's height and speed is also installed in each car to give passengers a visual sense of the 600-m/min speed of the elevator and the 72-floor height of the observation deck.

It is anticipated that the ultra-high-speed elevators that utilize these technologies will become a popular feature at the New Countryside Building in the Sky by providing users with convenient and comfortable means of getting around the building.

New Countryside Building in the Sky is a large multi-purpose building combining offices, a hotel, shops, and an observation deck that is being constructed as a symbolic building for Huaxi Village which has prospered through its iron and steel and textile industries. Construction started in August 2008 and the building is due to open in October 2011.

New Elevator Research Tower

Hitachi has constructed a new elevator research tower which, at 213 m, is the highest such elevator research facility in the world*. The tower was completed in April 2010 and is located inside the Mito Operations Division premises of Hitachi, Ltd.'s Urban Planning and Development Systems Company (located in Hitachinaka City in Ibaraki Prefecture, Japan) which serves as a base for research, development, manufacture, and other activities associated with elevators. In addition to use in the development of ultra-high-speed models and large-capacity models that are experiencing strong demand internationally, the research tower will also be used to enhance product competitiveness in global markets by developing technologies that can provide the product safety, efficiency, and comfort improvements required by elevators. The following describes these in detail.

The research tower has nine elevator shafts which are used for ultra-high-speed and high-capacity models as well as other general-purpose elevators. The research carried out using the shafts intended for ultra-high-speed and high-capacity elevators largely falls into the following two categories. The first is the development of ultra-high-speed models with speeds in excess of 1,000 m/min and the second is the development of high capacity models able to carry loads of 5 t or more at speeds of 600 m/min or more.

In addition to taking previously developed technology for large coiler units and high-capacity drive control units and applying this to ultra-high-speed operation, development of ultra-high-speed models also includes the development of emergency stop, speed regulator (governor), buffer, and other safety systems. The research tower is used to trial these technologies using actual ultra-high-speed operation. Also, because of the long travel length of these elevators, items of concern include passenger discomfort due to ear popping and the deterioration in ride comfort that can occur when factors such as warping of the guide rails cause increased vibration of the elevator car. To solve these problems, Hitachi is working on technology developments that include air pressure adjustment mechanisms that regulate the air pressure inside the elevator car and active guide units that suppress car vibration.

Meanwhile, the development of high capacity models includes further increasing the capacity of double-decker elevators that are considered essential to achieving greater capacity and developing a floor height adjustment mechanism that adjusts the separation between the upper and lower car. An elevator fitted with one of these adjustment mechanisms has been installed in the research tower and trials undertaken. The floor height adjustment mechanisms work differently to past models and its wider adjustment range and lighter weight make it compatible with a diverse variety of construction designs.

In addition to its intended use in the research and development of leading-edge products like those described above, other applications for the research tower include developing earthquake-tolerant technologies that allow elevators to return to service quickly after an earthquake and research. In this way, the new tower will contribute to society by making elevators more reassuring, comfortable, and convenient.

New research tower

[Building specifications]
Building area: 388 m^2
Building size: 213.5 m above ground, 15 m below ground
Number of floors: 9 floors above ground, 1 floor below ground
Construction started: March 2008
Completion: April 2010

* As of March 2010. As determined by Hitachi.