

# Industrial Systems



The 21st century is the “Century of Environment” calling for a radical shift in our approach toward the environment from consumption to recycling. Hitachi strives to contribute to the sustainable development of our society and improvement of the quality of life through the maximum use of skill, experience, and know-how accumulated as a result of Hitachi’s work to improve our society’s infrastructure from factories, recreational facilities, highways, and hospitals to railway stations, scientific research laboratories, vehicles, and homes.



## Kiln-type Gasification/ Melting System for Next- generation Waste Treatment



Kiln-type gasification/melting system pilot plant  
(Hitachinaka City, scale of process: 20 t/d)

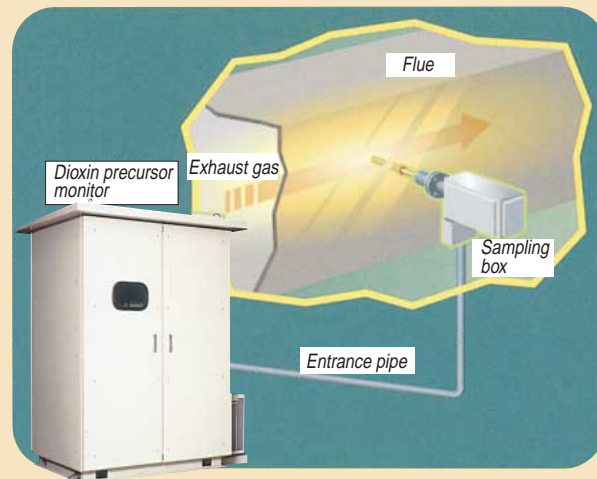
Hitachi developed a next-generation waste-treatment system that is environmentally friendly and that allows for the maximum exploitation of waste energy.

Waste is indirectly heated in a gasification furnace in an oxygen-free state at 450 to 500°C and is broken down into cracking gas and cracking residue (char). Because cracking gas contains little chlorine, soot, and dust, it can contribute to energy saving by being used as heating fuel. As for the char, unoxidized metal is collected (recycled) and the remaining char is sent to a melting furnace for swirling combustion at 1,300 to 1,400°C to render the ash molten and harmless when it is used as a heat source. At the same time, the system significantly reduces generation of dioxins by high-temperature combustion and cuts down the dioxin concentration in waste gases to 0.01 ng-TEQ/m<sup>3</sup> (N) or less. Also, it generates high-temperature and high-pressure steam to enable highly efficient power generation by combining melting-furnace exhaust heat and cracking-gas exhaust heat.

Because this system allows for the gasification furnace and melting furnace to be operated separately, the gasification furnace can also be used as a carbonized-fuel system.\*

\* Scheduled start of order-received plant operation in April, 2002.

## CP-2000 Dioxin Precursor Monitor

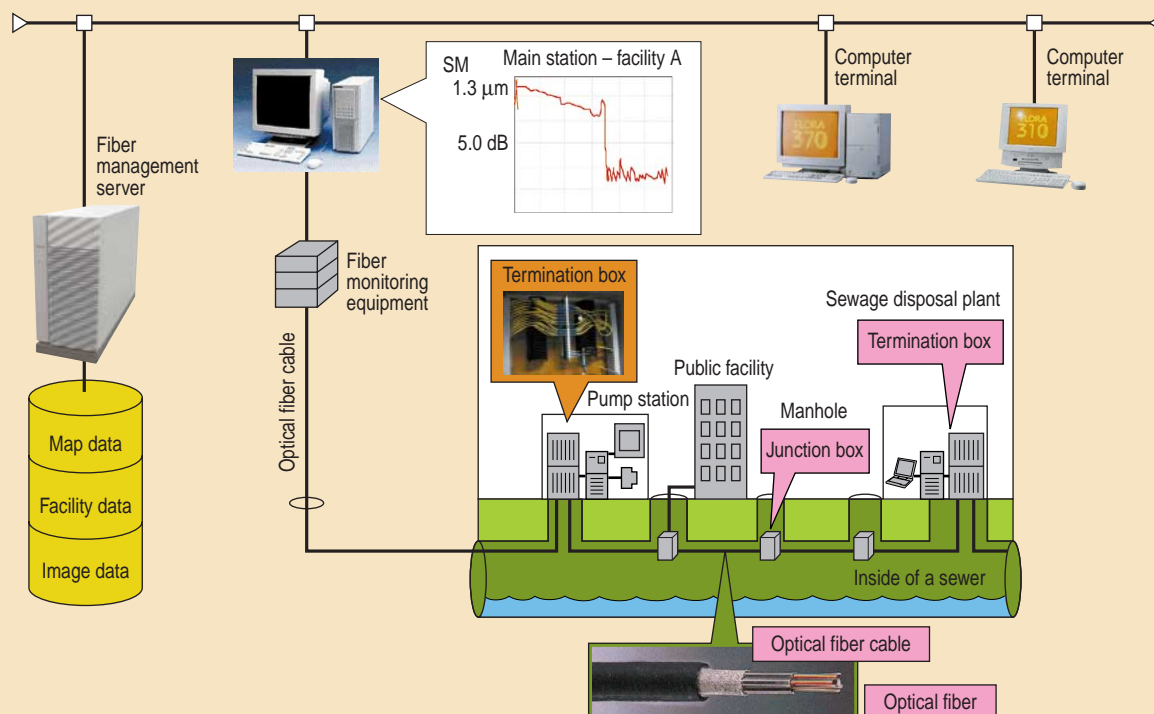


A view of the CP-2000 dioxin precursor monitor

Emissions of dioxins from refuse incinerators have become a serious social problem. In response to this problem, regulations will be introduced in December 2002, and measures to reduce these emissions are now underway. However, one of the main obstacles to such measures is the difficulty in directly measuring the concentration of dioxin in emission gas. A way to overcome this difficulty is, instead, to measure the amount of precursor gas (that is, chlorophenols) interrelated with the dioxin radicals.

Accordingly, the CP-2000 Dioxin Precursor Monitor has been developed for real-time, on-line measurement of these chlorophenols. This novel monitor incorporates atmospheric pressure chemical ionization (APCI) and a three-dimensional quadrupole mass spectrometer (3-D QMS) and provides high sensitivity in the order of several tens of parts per trillion. As well as providing high-speed continuous measurement (it takes less than a minute) of chlorophenols, it is anticipated that the monitor will help in developing guidelines to specify the most suitable combustion control conditions for dioxin reduction equipment.

# Optical-fiber-cable Management System



Configuration of management system for optical-fiber cables laid in sewers

The laying of optical-fiber-cable networks—a key facility of the advanced information society—along riverbeds, roads, and sewers is rapidly being expanded. The condition of existing networks is therefore continuously changing. Accordingly, a new optical-fiber-cable management system for accurate and efficient maintenance of all the fibers (from 24- up to 1,000-fiber optical-fiber cables) in these networks has just been implemented.

This system provides a fiber management function to manage the status of a huge amount of deployed fiber in conjunction with geographical data and a fiber monitoring function for monitoring fiber-cable faults.

Main features of the system are:

(1) PC system configuration for easy operation

The client/server configuration enables the system to be flexibly expanded and easily operated.

(2) History management of drawings by a four-dimensional (three dimensions plus time) geographical-data system

The base geographical-data system integrates three-dimensional display and time management. Records of past, present, and predicted fiber data are embedded in drawing data so that data of a certain time can be rapidly retrieved and manipulated.

(3) Automatically generated fiber-connection diagram saves database capacity and reduces number of man-hours for data

updating.

Fiber-connection diagrams are automatically drawn according to their connection positions within junction boxes enabling complicated fiber-connection information to be accurately and rapidly obtained. By using these diagrams to manage each branch point (i.e., junction box) in the fiber network, the system can easily handle rapid increases and configuration changes in managed fibers as a result of branching.

(4) Rapid and accurate detection of fiber faults and automatic map display of the failure location

Fiber faults in cables with spare fiber capacity can be detected. Optical time domain reflectometer (OTDR) monitors spare fibers, and when a fault occurs, it automatically detects the fault location and displays it on a monitor.

(5) Fiber route tracking

A fiber route is specified from the start point to its terminus; therefore, to find the best route to meet the specification, the system tracks all fiber routes and can rapidly identify open routes and available fiber routes.

(6) Fiber reservation

A user-reservation function for individual fibers facilitates fiber lending and installation management.



## Highly Reliable Industrial Personal Computer: FA MASTER HF-W25F/HF-W55F



Industrial personal computer: HF-W25F

The “FA MASTER HF-W25F/HF-W55F”—one of the FA MASTER HF-W series—for long-term stable operation, high reliability, and high cost efficiency in various fields such as factory automation (FA), semiconductor production, and signal control has been developed.

Main features are as follows:

- (1) Twenty-four-hour continuous operation, highly reliable system with 10-year durability and dependable design for control systems.
- (2) Long-term availability of the same computer model guaranteed for three years after their release to the market. Long-term maintenance service up to 10 years after delivery (optional)
- (3) Front access enables easy exchange of hard disks
- (4) HF-W25F: Celeron™\* processor (566 MHz)  
HF-55F: Pentium®\*\* III processor (850 MHz)
- (5) Open environment and excellent scalability  
Windows NT®/Windows® 2000, PCI/ISA bus 5 slots
- (6) Hot-swap RAID and PC cluster configuration possible
- (7) OS automatic restart and memory-leak check function
- (8) 150 mm high, thin body; meets UL, CSA, FCC and CE standards

RAID: redundant array of independent disks

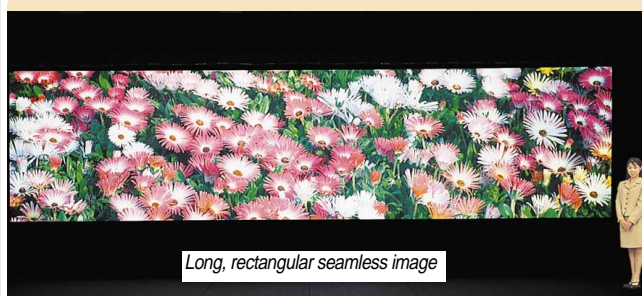
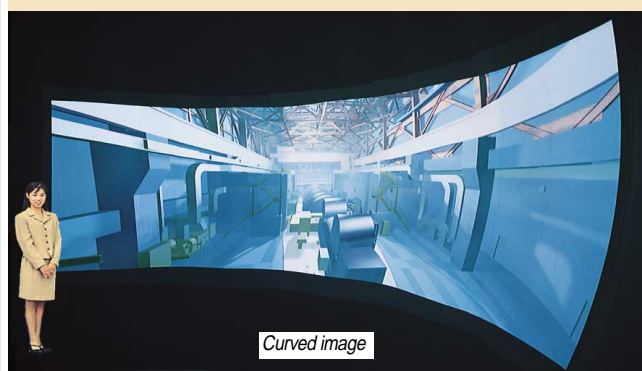
PCI: peripheral component interconnect

ISA: industry standard architecture

\* Windows NT® and Windows® are registered trademarks of Microsoft Corporation in the U.S. and other countries.

\*\* Celeron and Pentium® III are trademarks of Intel Corporation.

## Seamless, High-Resolution Display System



Seamless, high-resolution display

To meet the need for projecting a high-resolution, wide, bright image seamlessly on a large, curved surface, a new kind of display system has been developed.

This system produces a large, seamless (i.e., no visible joints) image on the screen by multi-projector system.

High-resolution images with up to two million pixels are now commonplace, but the images produced by single projector cannot match this high resolution because of its physical limitation on a lamp and a panel screen.

The system that Hitachi has developed, however, can produce such high-resolution images. It does so by utilizing several standard projectors to project several images onto a screen. These images are then seamlessly joined to form a single high-resolution image. Moreover, it is automatically adjusted so that it can be projected onto flat or curved screens.

Main features of the system are summarized below.

- (1) Bright, high-resolution images can be projected onto a wide screen by using standard projector equipment
- (2) Projection onto rectangular and curved screens of various sizes
- (3) Seamless images automatically produced
- (4) Flexible choice of image resolution and brightness

## High-efficiency Motor of the “Super Power” Series That Comply with EPAct



3.7-kW totally enclosed fan cooled type “Super Power”

In industrial plants, most of the electric power (approx. 70%) is expended by electric motors. Efficiency-improved motors are needed to save the energy, reduce the cost, and preserve the environment. In July, 2000, a new JIS standard was published in Japan to promote the use of high-efficiency motors. (JIS C 4212: Low-voltage three-phase squirrel-cage high-efficiency induction motors).

“Super Power” series motors comply with both the JIS (Japanese Industrial Standards) and the EPAct (Energy Policy Act of 1992) even in compact body and weight as a result of the following. (1) New design of the stator core and windings; (2) new magnetic steel sheets; (3) aluminum-alloy housing with good cooling characteristics.

## Enhanced Small-end PLCs of the EH-150 Series



Communication modules



Input and output modules

Newly developed modules of the EH-150 series PLC

Hitachi has developed the following new modules for its small-end PLC (programmable logic controller) of the EH-150 series: (1) a CPU module with a larger programming memory that enables faster processing speed; (2) communication modules responding to open networks, such as the Ethernet\* at the information level and the DeviceNet\*\* at the device level; (3) 64-points input and output modules with connector wiring. The EH-150 series meets various application requirements for transporting systems and devices.

The modules have the following features.

- (1) A processing speed of basic commands: 0.1 micro second per command (10 times faster than that of the H series PLCs);
- (2) Programming-memory capacity: 48-k steps (3 times larger than that of the H series PLCs);
- (3) Improved communication functionality (supporting RS-232C/422/485).

\* Ethernet is a trademark of Xerox Corp. in the US.

\*\* DeviceNet is a registered trademark of Open DeviceNet Vendor Association.

## MICRO-EH Series PLCs with Various Functions in a Compact Body



All-in-one-type PLCs of the MICRO-EH series

PLCs (programmable logic controllers) of the MICRO-EH series are of all-in-one-type with inputs and outputs in a compact body.

The MICRO-EH series PLCs have the following features: (1) a size reduced to 60% of that of Hitachi's H-board-type PLCs; (2) a programming language compatible with that of the EH-150 and H-series PLCs; (3) a pulse-counting input, PWM (pulse width modulation) output and interrupt-input functions available as standard; (4) batch control of a maximum of 32 units through an RS422/485 communication port by a single personal computer; (5) analog input and output functions available as standard.

These functions enable controlling conveyers, packing machines, assembling machines, air-controlling machines, and other controlling systems.

## Multi-functional High-performance Inverter of the SJ300 Series



SJ300 inverter and internal option boards

Recently, manufactures across all industries have been under pressure to develop a customer-centered structure capable of responding quickly to the needs of individual customers. Many have come to understand that the structure of a manufacturing organization must be changed from its emphasis on the hierarchical system to the emphasis on the distributed system. The intelligence of a cell in the system will be the key to building distributed manufacturing. A typical cell in the system is an inverter. In distributed manufacturing, the most important thing is the intelligence of the inverter needed to perform a host of peripheral functions around the cell in the system. Hitachi, Ltd. has developed a high-performance inverter of the SJ300 series which can be used in distributed manufacturing.

The SJ300 inverter has excellent characteristics enabling 200% torque at 0.5 Hz by sensorless vector control. Particularly, it can be used to design internal option boards which expands its applications. The SJ300 inverter enables designing different internal option boards for complicated control systems and communication. The SJ300 inverter can be used in the following internal option boards.

- (1) SJ-FB, which enables full vector control of position and torque with high accuracy.
- (2) SJ-DG, which can transmit 16-bit parallel data.
- (3) Open networks.

SJ-DN, which supports DeviceNet\* for US market.

SJ-PB, which supports Profibus-DP\*\* for European market.

SJ-LW, which supports Lonworks\*\*\* for HVAC market.

The application of the internal option boards based on the SJ300 inverter will expand in the future.

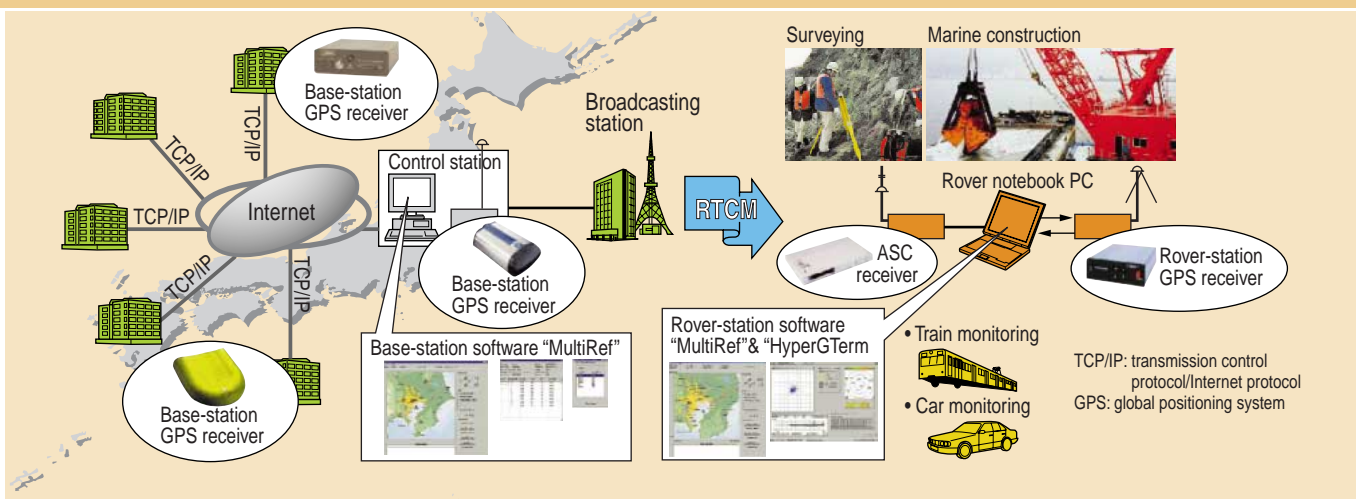
\* DeviceNet is a registered trademark of Open DeviceNet Vendor Association.

\*\* Profibus is a registered trademark of Profibus Nutzer Organization.

\*\*\* Lonworks is a registered trademark of Echelon Corporation.



# Wide-area Network-based RTK (Real-time Kinematics) Correction System



Configuration of the wide-area network-based RTK correction system

We have developed in cooperation with the DX ANTENNA Co., Ltd., and Asahi National Broadcasting Co., Ltd., wide area network-based RTK correction system that enables realtime positioning in a broad area with cm precision.

This wide-area network-based RTK correction system is based on technologies that enable creating a VRS (virtual reference station) near the observation point and receiving VRS correction

data on ASC (audio subcarrier channels).

Using the wide-area network-based RTK correction system, we have expanded the radius of RTK positioning from 15 km to 100 km.

We are now developing a receiver for the wide-area network-based RTK correction system.

## Tandem Cold Mill at Nisshin Steel



Tandem cold mill at Nisshin Steel

Hitachi supplied Toyo Works of Nisshin Steel Co., Ltd., with a continuous four-stand tandem cold mill coupled with an entry side pickling line including automatic-roll-shop equipment to produce high-quality cold-rolled sheets for household appliances.

This equipment was installed with the pickling line already commissioned and being commercially run using a unique underground pass technology.

The commissioning was completed, and the commercial operation began in May, 2000. Monthly production increased rapidly and smoothly to the full plant capacity.

Hitachi also supplied Toyo Works with mechanical, electrical, and computer equipment including an automatic roll shop. A high degree of automation of the plant operations including automatic roll grinding and automatic roll handling has enabled reducing the number of workers.

The equipment characteristics are as follows.

- (1) The six-high UC (Universal Crown) mill is used in all stands.
- (2) Intermediate roll shifting in all stands enables a much improved strip crown, shape controllability, and high productivity.
- (3) The roll shop is directly connected to the rolling mill to enable automatic operation.

## High-field-performance Open-MR Imaging System “Altaire”



“Altaire”

Built upon Hitachi's success in MRI technology, Altaire takes it to the next level with its higher field strength and advanced gradient and RF systems to enable high-field performance and open-MR comfort.

Superior performance begins with a high-homogeneity vertical-field superconducting magnet. The advanced high-slew-rate gradient system enables high speed and high resolution while the multi-channel digital RF-receiver system and a high-speed computer workstation enable superior clinical quality and system flexibility.

Altaire's magnet incorporates an asymmetric two-post architecture in its design, which is Hitachi's signature in maximum-openness system design. A panoramic open design provides patients with a comfortable scanning environment, while the magnet enables high-field performance.

An advanced flat gradient system supports Altaire's ultra-rapid acquisition and sub-millimeter-resolution imaging capabilities. The system's high slew rate shortens the TE and inter-echo time and enables long echo train lengths with ss-EPI ss-FSE. A high-maximum amplitude enables combining rapid acquisition and demanding scan parameters to generate thinly sliced, small-FOV, high-resolution images. A sophisticated design for digital eddy current compensation ensures parameter flexibility and consistent image quality in a wide range of applications.

An important factor determining the success of the open MRI system is patient comfort. Patients will choose a system based upon comfort, and physicians will make referrals based upon image quality. Altaire offers an ideal combination of image quality and patient comfort, meeting the needs of both physicians and patients.

The best measure of MRI performance is its clinical capabilities. Apart from enabling a range of standard applications, Altaire has a number of advanced capabilities, such as ss-EPI and PC-MRA. Altaire's powerful gradient and RF systems and computer workstation have provided a platform to enhance imaging for years to come. It continues Hitachi's tradition of satisfying clinicians, radiologists, and patients alike.

## Optical Topography System for Measuring Brain Activity



Optical-topography system Model ETG-100 is portable.

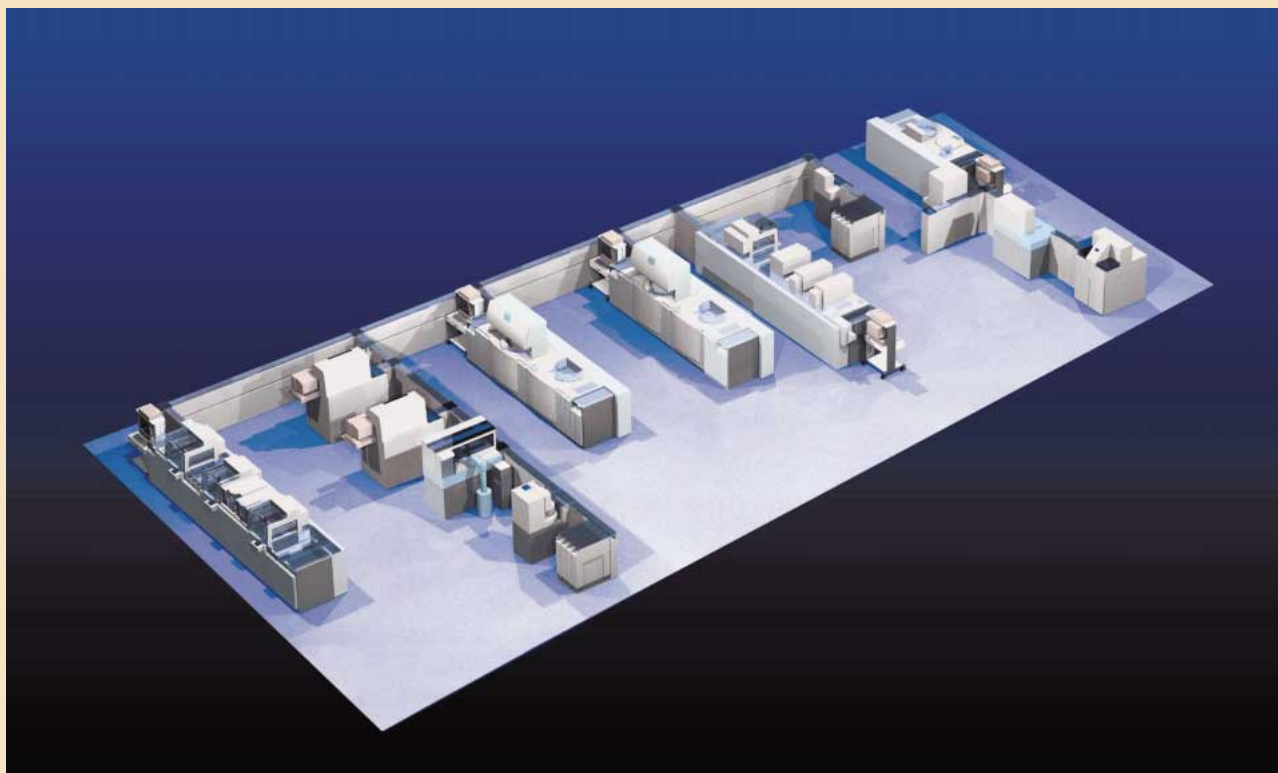
An optical topography system enables taking topographic images of human brain activity from the scalp non-invasively by using near-infrared light. Newly invented in Hitachi as a brain function imaging system and developed as a clinically available brain diagnosis system, it measures concentration changes of oxy- and deoxy-hemoglobin in the brain cortex. With 24 sets of 35-30-mm distanced irradiation and several detection-probe pairs efficiently grouped into ten irradiation probes and eight detection probes, it simultaneously measures 24 points of hemoglobin concentration changes in the subject's head with 0.1-s repetition. A flexible optical fiber probe and a compact system console, which are special features of the system, make the system portable and minimize the use of patient-restraint devices in clinical settings.

Because the system is non-invasive and ensures that the patients are comfortable, it can even be used to measure the brain function of newborns.

It is already being used in several clinical procedures, for example, in epilepsy-focus detection, language-dominance hemisphere determination, and measurements of the brain function of newborns. Compared to the conventional brain function measuring system, f-MRI, the PET-optical topography system enables obtaining function images easily and at low cost. We plan to widen its application in clinical procedures.



# Integrated Automation System for Clinical Laboratories



*Integrated total laboratory system based on the modular concept*

Recently, most clinical laboratories have come under pressure to reduce costs and meet an increasing number of standardization requirements. Additionally, the services provided by clinical laboratories must be improved.

To meet these challenges, clinical laboratories must increase their efficiency. The key words today are “automation of routine testing procedures” and “integration of laboratory analyzers.” Introducing these concepts frees laboratory personnel from troublesome processing improving cost-effective management. These innovations not only reduce the cost, but also shorten the turnaround of testing procedures.

The approach toward integrating several analyzers is as follows.

First of all, there are different types of analyzers used under routine testing requirements. Especially, in clinical laboratories, these analyzers are divided into those used for common testing and those used for special testing. The two types must be integrated. Second, for cost-effective management, unnecessary

processes in and excess personnel for analyzers must be eliminated. For example, the number of operators, maintenance processes, and consumer products should be reduced.

To achieve these goals, we believe that each laboratory should apply the most suitable integrated laboratory system. We developed a modular concept, that consists of a standardized analyzer, the size of a module and a standardized interface. This concept enables providing each laboratory with a suitable analyzer combination. We are now expanding the modules to include pre-analytical processes.

In conclusion, Hitachi developed a modular concept for cost-effective management that combines pre-analytical and analytical processes. This combination will result in downsizing, decreased process, and variation in clinical laboratories. We plan to focus on the borderless integration in clinical laboratories by using new analytical modules, for example, immunoassay modules, not just chemical modules.

## Lung-screening CT System



A Japanese study suggests that the lung-screening CT system is an effective mass-screening tool. The vehicle shown carries a sub-second spiral CT scanner and was purchased with funds received from the TAKARA-KUJI-Japanese Lottery.

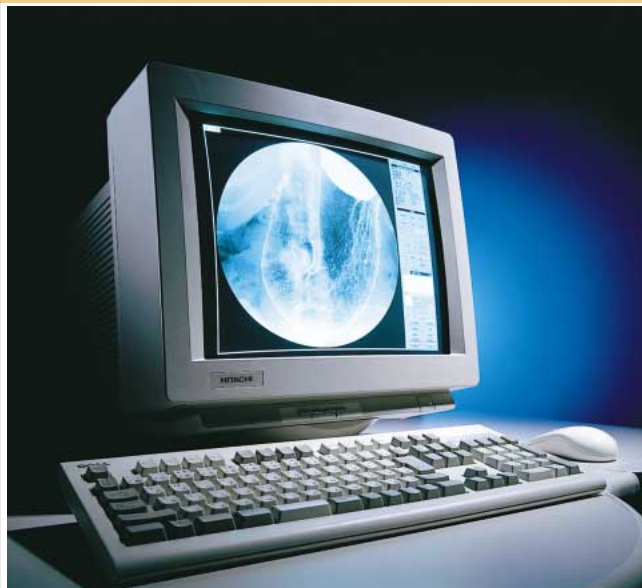
The death rate from lung cancer in Japan has reached alarming proportions. A lung-screening CT (LSCT) system is needed that can detect lung cancer in early stages which will help decrease the death rate from the disease. Since 1992, we have been working on developing an LSCT system for a pilot study planned by National Institute of Radiological Sciences.

The LSCT system consists of a spiral CT scanner and a diagnostic console. We used a CT scanner of the RADIX series with low-x-ray-dose scanning parameters and a CT diagnostic console of the DC-1 series for the LSCT system. The RADIX scanner has the following characteristics: the scanning speed is 1 sec per rotation, the reconstruction time is 1 sec per image, the table-feeding speed is 20 mm per sec. We also developed a sub-second-scanning CT scanner (sonic scan) that is attached to a vehicle and is intended for studying mobile CT scanners. The sonic scan has the following characteristics: the scanning speed is 0.7 sec per rotation, the reconstruction time is 0.7 sec per image, the table-feeding speed is 28 mm per sec. The vehicle is equipped with a diesel engine.

Currently, medical professionals are gathering data to analyze the effectiveness of the LSCT system in lowering the death rate from lung cancer. We hope to further improve the LSCT system.

We are now developing new technologies to support our LSCT system. One of these technologies enables crystal-view observation improving detection of grand glass objects in patients with lung cancer in early stages.

## Real-time Digital Radiography System



Real-time digital-radiography-system console

Recently, real-time digital radiography (DR) systems using x-ray image intensifiers and imaging cameras have begun to be widely used in various medical fields. In an attempt to respond to the needs of clinical professionals and make the systems more user-friendly, we developed a new DR system with an image-processing unit that enables better imaging.

For the imaging system, we developed a multiple-mode 4-million-pixel CCD camera (also switchable to 1 million pixels) that is based on a newly developed sensor, and can be used both in fluoroscopy and in radiography. The resulting system is smaller in size and enables higher image quality compared to that of the previous system. Using the system, high-quality images can be taken enabling detailed diagnoses of the digestive tract.

The Windows NT®-based image-processing unit has the following advantages:

- (1) It makes it possible to display optimum images immediately after the exposure due to auto gamma/window/level fitting, which automatically optimizes these factors depending on ROI (region of interest) and the thickness of the body of the patient.
- (2) It enables high-speed imaging using multiple high-speed hard disks (RAID System), thanks to which operators can concentrate on the examination and don't have to worry about the storage capacity even in high-definition acquisition-mode radiography and serial radiography.
- (3) It meets the requirements of the digital subtraction angiography function in interventional radiology procedures.
- (4) It enables easy connection to other modalities and medical networks because the output data format is subjected to the requirements of DICOM (digital imaging and communications in medicine), which enables sharing medical imaging data and information inside the network.
- (5) It enables concurrent processing of images, data storage, and hard-copy printing.
- (6) It simplifies operation methods.

\* Windows NT® is a registered trademark of Microsoft Corporation in the US and other countries.

## New Machine-roomless Elevator Based on Universal Design



Neutral design using stainless steel to match different building designs

Hitachi has launched a new machine-roomless elevator, which is the first elevator on the market to fully adopt the universal design principles. The concept behind the new machine roomless elevator is "anybody can use it, and it's exquisite."

The main features of the elevator are as follows.

- (1) Three packages of the universal design make it easier for the customers to choose the right package.
- (2) In addition to the "standard package," there is a "thoughtful package" which is a standard-package elevator equipped with a horizontal car-operating panel, and a "recommended package," which is an elevator adjustable for wheelchair specifications.
- (3) The elevator has a neutral design and is made of stainless steel to match different building designs. The brightness and texture of the ceiling light can be selected to suit the customers' tastes.
- (4) A full lineup of 36 models from low-speed to high-speed elevators.
- (5) The numbers on the floor buttons on the operating board are raised to provide a sharp contrast and start flashing upon the arrival at the destination floor.
- (6) To enable easy view for people in wheelchairs, the back wall of the car is equipped with a full-length mirror from the top edge of the kick plate to the ceiling.

## 109 Escalators for Guangzhou Subway Line 2



109 escalators will be installed in 16 of 20 stations, from China Export Commopitex Fair Station to Sanyuanli Station.

Guangzhou Hitachi Elevator Co., Ltd., a joint-venture company established by Hitachi, Ltd., and Guangzhou Guangri Elevator Industry Co., Ltd., secured a Guangzhou Subway Line 2 project with the Guangzhou Metro Corporation. The project is for the installation of a total of 109 escalators.

This subway project is carried out to ease the traffic in the center of Guangzhou city, where Line 1 has completed in June, 1999. The Guangzhou Subway is the third subway in China followed by Beijing and Shanghai.

Line 2 runs from north to south through the center of Guangzhou city. The total length of Line 2 is 23.2 km and there are 20 stations along the way. 109 escalators will be installed in 16 of these stations, from China Export Commopitex Fair Station to Sanyuanli Station. These escalators are designed for energy-saving operation with micro-inverter controls.

Sensors located in the upper and lower terminals detect the passengers on the escalators. When there are no passengers, the escalators will decelerate automatically to enable energy-saving operation. The project is expected to be completed around June, 2004.

## A Tilted Limited Express of EMU Series 885 for Kyushu Railway Company



A tilted limited express of EMU Series 885 for Kyushu Railway Company

This train called White Kamome was put into operation on the Nagasaki and Nippo Lines of the Kyushu Railway Company in March, 2000. For a luxury feeling, the floor of the first-class passenger car has a cross-striped pattern of grains and the seats are made of leather. The train has a fixed 3M3T formation.

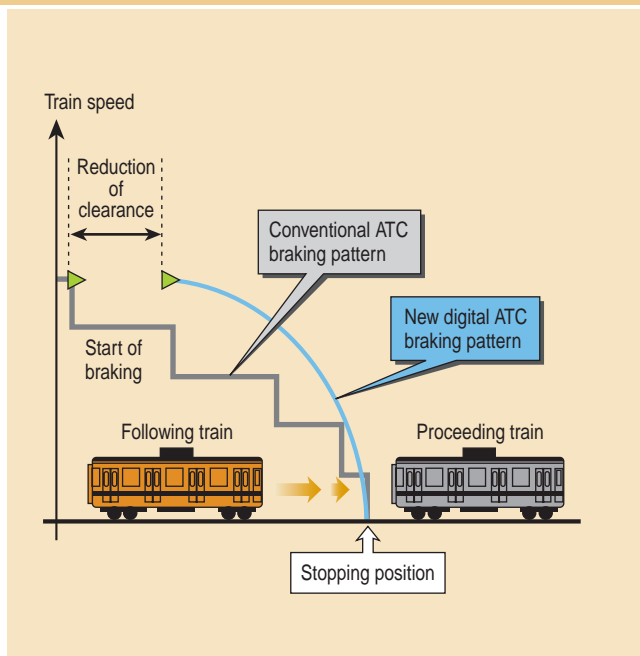
The car body is an aluminum-alloy double-skinned construction integrating the outer sheet and the framework. The main converter/inverter consists of a 3-level line converter and a 2-level traction inverter using an IGBT (insulated gate bipolar transistor).

The control of the traction motors is based on vector control to save the energy and reduce the noise.

Specifications are as listed below.

- (1) Gauge: 1,067 mm;
- (2) electric system: 20 kV AC, 60 Hz;
- (3) train formation: 3M3T;
- (4) train performance: 12-190 kW;
- (5) carbody: aluminum-alloy double-skinned, tilted;
- (6) truck and driving system: bolsterless truck, air spring, flexible coupling drive;
- (7) control system: PWM converter/VVVF inverter control with regenerative braking;
- (8) maximum service speed: 130 km/h

## New Digital ATC System for East Japan Railway Company



Train speed control by new digital ATC

Conventional ATC (automatic train control) systems calculate the train speed for each blocking section and control the speed of all trains. These operations are performed section by section through analog frequency transmission from the ground equipment.

In the new digital ATC, the ground equipment calculates the distance that a train can travel safely, and sends this information to all trains. An on-board microcomputer autonomously calculates the appropriate braking pattern and controls the train speed based on each train's position.

The new system enables ideal train speed control significantly improving the train performance, which in turn allows for high-density train operation. The system does not require huge relay-based equipment, and is based on the latest information and control technologies, such as network and digital signal processing.



## Multi-purpose Genetic Analyzer PRISM 3100



Genetic analyzer PRISM 3100

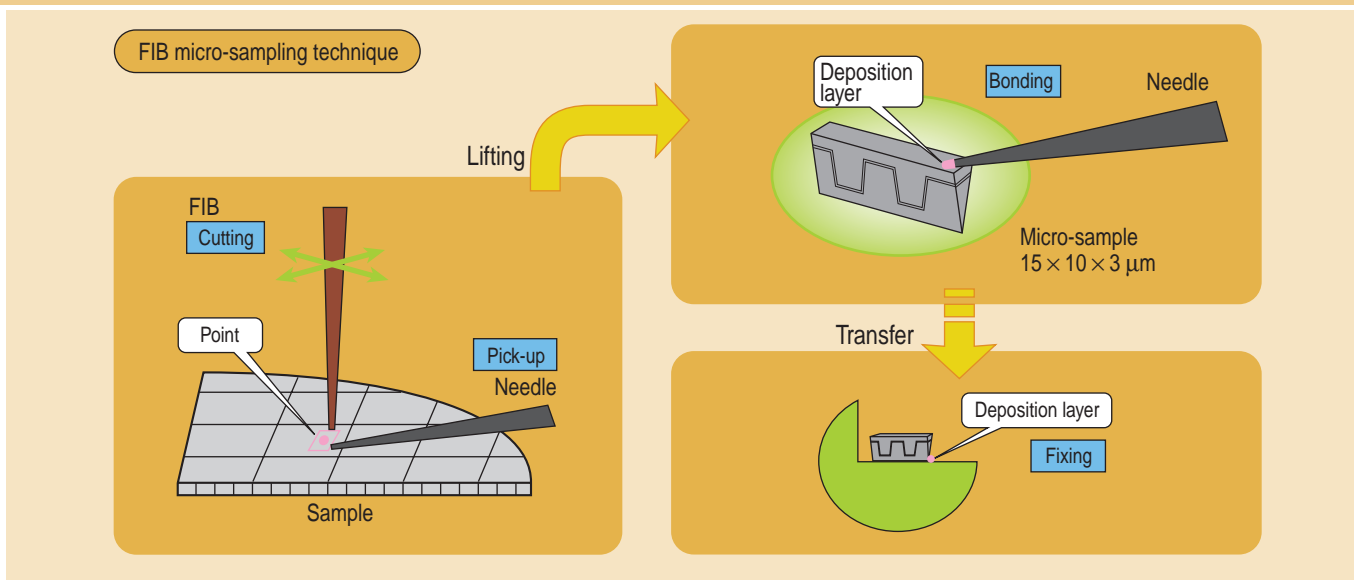
As a result of recent advances in genome science, genetic analysis has gone beyond pure academic research moving into pharmaceutical and medical industries where the focus is on discovering new medicines and developing diagnostic tools.

We have developed a genetic analyzer, PRISM 3100\*, as part of our strategic partnership with the Applied Biosystems Group of the US.

The PRISM 3100\* is a middle-range throughput instrument, capable of a parallel analysis of 16 samples and fully automated 24-hour operation, including sample loading to data analysis. Fragments of DNA are separated by electrophoresis with a pre-assembled array of 16 capillaries, which are fine-quartz tubes with an inner diameter of 0.05 mm. The DNA fragments are detected by laser-excited fluorescence, and a CCD (charge coupled device) image sensor. The instrument has been optimized to support a variety of applications beyond DNA sequencing, including fragment analysis used in human identification and forensic science.

\* PRISM 3100 is a trademark of Applied Corporation.

## A New Focused-ion-beam Micro-sampling Technique for TEM/STEM Observations of Site-specific Areas

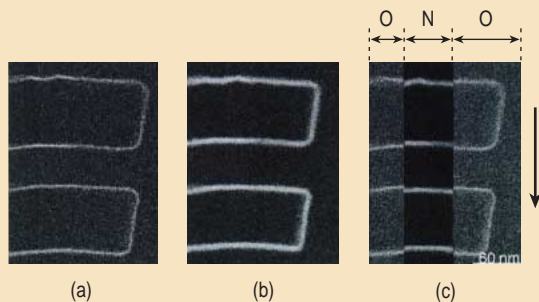


Flow of  $\mu$ -sampling

Hitachi developed a new focused-ion-beam (FIB) micro ( $\mu$ )-sampling technique that facilitates specimen preparation in transmission electron microscope (TEM) and scanning transmission electron microscopy (STEM), while allowing for the chip and wafer samples to remain intact. A deep trench is FIB-milled using gallium to dig out a small, wedge-shaped portion of the sample (or a microwedge) from the area of interest, leaving a small, bridge-shaped portion (or a microbridge) to support the microwedge. A metal needle is then manipulated to lift the microwedge, i.e., the  $\mu$ -sample. FIB-assisted deposition (AD) is used to bond the needle to the  $\mu$ -sample. The FIB milling of the microbridge separates the  $\mu$ -sample from the chip or wafer. The

separated  $\mu$ -sample is mounted onto a TEM grid and secured using an FIB-AD. The  $\mu$ -sample is further FIB-thinned to a strip, about  $0.1 \mu\text{m}$  thick. Figure shows a schematic flow of the  $\mu$ -sampling. This technique permits both site-specific cross-sectional and plan-view TEM/STEM  $\mu$ -sampling. By using an FIB/TEM (STEM)-compatible sample holder, TEM observations and FIB milling can be done repeatedly, so that the exact area of interest could be prepared for analysis by TEM. The  $\mu$ -sampling technique was initially applied to microdevices, wafers containing grown-in defects, and MR heads and has proved to provide a useful technique for TEM/STEM observations of site-specific areas.

## Real-time Elemental Mapping System with Nanometer Resolution



Elemental images of a capacitor in a 64-Mbit DRAM

(a) Oxygen and (b) nitrogen images, and (c) the image when switched from oxygen to nitrogen and back to oxygen. The vertical arrow shown in (c) indicates the direction of the electron-beam scanning.

The development of semiconductor devices, such as ULSIs, has been moving toward developing devices of a nanometer size with gate oxides 2 nm thick or less. Magnetic recording heads now consist of multilayers 1 nm thick or less. To analyze materials and manufacture such devices, elemental maps with high spatial resolution are needed.

Transmission electron microscopes (TEMs) and scanning transmission electron microscopes (STEMs) can be effectively used to observe specimens with atomic resolution, while electron energy-loss spectroscopy (EELS) can generate elemental and chemical data. We have developed a real-time elemental mapping system equipped with a STEM and an energy filter. In this system, electron beams 0.5 nm in diameter are scanned over a specimen, and the electrons transmitted through the specimen can be analyzed during the scanning by using the energy filter to generate real-time elemental maps and electron energy-loss spectra.

This system has two advantages. First, real-time elemental maps can be generated with spatial resolution of 1 nm when electron beams are scanned over the specimen. Because the objective element can be switched to a different one during the observation, the boundary between the two elements can be determined with nanometer resolution. For example, figures (a) and (b) show oxygen and nitrogen maps of a capacitor in a 64-Mbit dynamic random access memory (DRAM). When generating the elemental image shown in figure (c), we switched the objective element from oxygen to nitrogen and back to oxygen. The scanning direction of the electron beam was from top to bottom in the image, as shown by the vertical arrow in figure (c). Figure (c) clearly shows that there are 2-nm-thick silicon oxide layers detected with nanometer resolution outside 3-nm-thick silicon nitride layers. Second, while observing elemental maps, we can arbitrarily turn on magnification and select the observation area. These functions enable searching the desired areas in specimens.

## Adaptive Cruise Control (ACC) System



Adaptive cruise control (ACC) system

The NISSAN MOTOR Co., Ltd., has completed the development of an ACC system for "Cima" and "Primera" and has started its production.

The ACC system enables keeping a constant distance between the car equipped with the system and a car ahead of it by measuring the distance to and the relative speed of the car ahead and controlling the engine torque, gear position, and brake force.

A conventional auto-speed control system only enables keeping the speed constant and cannot control the speed if there is a slower car in front of the car equipped with the system. The ACC system can control the speed even in such situations and enables keeping a constant distance, which is very convenient to the driver.

The system consists of the following parts.

- (1) A radar that detects the distance.
- (2) An ACC ECU (electronic control unit) that controls the car speed based on the information from various sensors and the actual situation and sends commands to the engine, transmission, and brake system.
- (3) A brake ECU that controls the brake force.
- (4) An active booster that applies brakes automatically based on the command from the brake ECU.

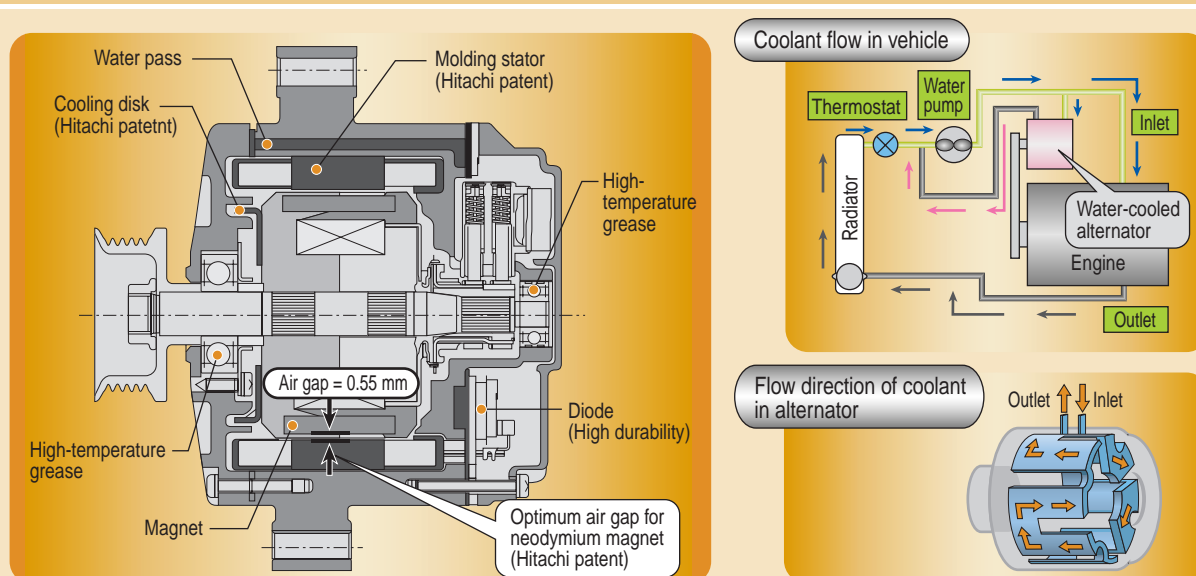
The newly developed devices include an ACC ECU for "Cima," an ACC ECU, and an active booster for "Primera."

The system for "Cima" is a luxury system for which a white-line recognition camera unit for the lane keep system is currently being produced.

The ACC system for the "Primera" is its low-price version; its goal is to increase the popularity of the ACC system. The ECU combines an ACC unit and a brake-control unit in one box saving the space and cost. The size of the active booster, which includes solenoid, is the same as that of an ordinary booster, and it can be built in into mid- or small-size cars. Hitachi group supplied ACC, ECU, the active booster, and the camera unit.

Hitachi now plans to develop a low-cost high-performance original system based on a millimeter wave radar as a Tier1 supplier.

# High-output Water-cooled Alternator



Configuration of high-output water-cooled alternator

Market requirements for automobile alternators are becoming more stringent, especially in recent years. These requirements call for alternators of small size, high output, high efficiency, low noise, and thermal durability. In an attempt to meet these requirements, we developed a water-cooled alternator. To develop the alternator, the following new materials and devices were adopted.

- (1) High-thermal-conductance resin for cooling stator coils
- (2) A high-flux magnet between rotor claw poles
- (3) A high-durability diode for thermal fatigue
- (4) A water pass with lower pressure loss

Based on these new materials and devices, Hitachi's water-cooled alternator has the following advantages.

- (1) Compact and higher output: 615 W/kg (about 2.2 times

higher compared with conventional air-cooled alternators)

(2) Low noise: (20 dB lower than conventional air-cooled alternators)

(3) High efficiency: (10% higher than conventional air-cooled alternators)

(4) High allowable ambient operating temperature: (30°C higher than conventional air-cooled alternators)

Hitachi's water-cooled alternator is most suitable for luxury cars, midsize cars, heavy trucks, and other special cars with a large electric load. In addition, drastic improvement of output characteristics compared with those of conventional alternators can enable completely new systems, such as a motor 4WD system.

## SelecTop Glass



Examples of delivered systems

"SelecTop Glass"\* is a new display system that can display full-color luminous images in display windows and on glass panels. The system has been attracting a lot of attention from a wide range of industries that use advertisement tools, such as electronic POP (point of purchase), and guidance systems.

In the SelecTop Glass system, images are projected by a data projector onto a transparent holographic screen from the rear with a 35-degree angle. Because about 70% of the incident rays go toward the front, the projected images can be seen from the exterior even in broad daylight. In addition, because the screen is transparent, it does not block the view from the inside of the room creating a new way of projecting space.

[Installation examples]

"Aquarium SelecTop Glass" at Wild Blue Yokohama (a theme park)

A screen installed at the back of an aquarium creates fantasy in combination with bubbles and illumination in the aquarium

"Multi-screen SelecTop Glass" installed at Kubota Corporation

SelecTop Glass is used to display the features or cross-sectional drawings of real objects put behind the screen. Three 40" screens can be placed horizontally without any gap.

A 60" screen has been on sale in October, 2000.

\* SelecTop Glass is sold as "AIRSHOTM" in the US.

# Powerful Clean Full-access PAM Air Conditioner “Shirokuma-kun”



The full-access PAM air conditioner “Shirokuma-kun” (above), and the full-access cleaning panel that opens from the center for easy-access cleaning of the room unit (right).

Hitachi’s residential-use air conditioner and dehumidifier (the full-access PAM) features turbo PAM (pulse amplitude modulation) for increased power and energy savings, as well as a proprietary “full-access cleaning panel” making the air conditioner much easier to clean.

## *Turbo PAM Means Better Efficiency Coupled with More Power*

The new turbo PAM system has been implemented on Hitachi’s air conditioners and this further boosts the already impressive performance of the inverter PAM control scheme that reconciles energy savings with increased power. With these impressive enhancements, the 2.8-kW model achieved the best performance in the industry: consuming only 908 kWh, it warms up a typical room in under five minutes when the outdoor temperature is 2°C.

### (a) Wide-range PAM: enhanced PAM control

Improving upon our own PAM control technology, the wide-range PAM runs a DC motor that drives a compressor for low to high speeds. The voltage range and power performance have been improved another 10 volts over last year to support a range from 140 volts to 390 volts.

(b) Eco-strong motor: enhanced efficiency from a new structure coil and high magnetic rotor

Efficiency was improved roughly 2% by eliminating a superfluous coil that caused losses in the stator part of the motor, and by optimizing the arrangement of 16 neodymium magnets (with three times the magnetism of ordinary magnets) in a star configuration in the rotor. (The comparison was done using a nearly identical model motor, the RAS-2810LX, developed last year by Hitachi.)

(c) Twin-charge system: better efficiency by modifying the flow of refrigerant

Air conditioners provide heating by first capturing heat from the air when refrigerant changes from liquid to vapor form in an outdoor heat exchanger, then emitting the heat into the room that is produced when the vapor is converted back to liquid by the heat exchanger in the room. In conventional air conditioners, the endothermic efficiency at the outdoor heat exchanger is reduced when vapor is mixed with the liquid state refrigerant, but the endothermic efficiency of the twin-charge system is improved by separating the vapor out beforehand via a bypass, and then delivering the all liquid state refrigerant to outdoor heat exchanger. This technology is implemented on 2.8-kW class and higher models.

*A Triple-clean Effect: Clean Air, Dehumidification, and “Cool Air on Bare Skin”*

(1) W-catch air purifier: powerful new weapon for eliminating dust mites, mold, pollen, and noxious odors

Performance has been enhanced by bending a filter made of a newly developed heavy-duty charge processing material into a W-shaped heater; this increased the surface area of the air passage, slowed the velocity of the same volume of air passing through the passage, and improved the dust collecting performance of the filter. Filter life has also been extended from about three months to around a year (compared to other Hitachi filters).

(2) Source of contaminants held in check: “crisp and dry” dehumidification that lowers humidity to 40%

One of the best ways to prevent dust mites and mold from occurring and propagating is to reduce the humidity of the room. The air can be dehumidified at a set humidity of 40%, so the occurrence and propagation of mold and dust mites are practically eliminated.

(3) An air conditioner that can be kept clean: industry’s first full-access panel for cleaning equipment inside the housing

(a) Regular care and maintenance is a joy using the access panel that opens to the right and left from the center of the unit

This easy access makes it very simple to clean the filter and other parts of the air conditioner. Note that cleaning the filter on a regular basis conserves 5-10% energy.

(b) Top and front surface panels can be detached as a single unit

The new panel opening to left and right makes it possible to detach both the top and front surface panels as a single unit, thus giving access for the first time to the upper inlet port so it can be washed and kept clean. Note too that the width of the panel is only half that of earlier models, so it takes up relatively little space and fits easily into a kitchen sink for washing.

(c) After the access panel has been opened and the filter removed, the inside of the housing is much more accessible from the top because there are relatively few ribs.

This makes it possible to get a vacuum cleaner extension into places that accumulate dust and that were previously difficult to clean. Now, a number of structural design enhancements make it possible to use spray cleaners on the equipment inside the full-access PAM air conditioner housing: one can now easily see the interior of the air conditioner by simply removing the panel and filter. In addition, Hitachi has developed a special spray cleaning agent (that is sold separately), thus making it possible for the first time in the industry for people to easily clear the heat exchanger with a household spray cleaning agent.

Cleaning the heat exchanger with the spray cleaner not only removes noxious smells and grime, it also makes the exchanger more energy efficient.



## Energy-saving and High-speed-cooling Twin PAM Refrigerator for Fresh Food Storage



*Twin PAM refrigerator for fresh food storage*

Hitachi developed a twin PAM (pulse amplitude modulation) refrigerator that features a high-speed cooling system. It allows food to retain more of its original freshness and flavor. It chills beer cans to a suitable temperature in 30 minutes.

The main features of the refrigerator are summarized below.

(1) A speed cooling circulation fan directs air as cold as 1°C to warm food items stored in the refrigerator. It enables quick cooling of food, which is much faster than cooling in the freezer compartment.

(2) A PAM control system enables high-efficiency operation of both the compressor motor and the cooling fan motor. For the 455-L model, the electricity consumption was 1/3 of that of a 10-year-old equivalent 450-L model (360 kWh/year for the 455-L type refrigerator).

(3) The speed cooling circulation fan also enables quick thawing of food. It takes only 15 minutes to thaw frozen meat for cooking.

## “Shiroy Yakusoku,” Meaning White Promise, the World’s First Fully-automatic Washing Machines Having Ion and PAM Washing and Rinsing Functions



*“Shiroy Yakusoku” fully automatic washing machine, with PAM-ion washing and rinsing functions, Model “NW-8PAM2”*

Hitachi is now launching two models of fully automatic washing machines, the “Shiroy Yakusoku” series. These washing machines feature ion washing and rinsing functions which clean city water to make it suitable for washing and rinsing clothes and PAM (pulse amplitude modulation) control functions which sustain high power and save energy at the same time.

The main features are summarized below.

(1) The “ion washing and rinsing functions” come standard with these models, which have been designed to clean clothes very effectively. They remove detergent residues that may discolor laundry, and enhance clothing’s moisture-absorbing properties by removing metallic ions from city water, and preventing detergent scum from remaining in the laundry.

(2) To facilitate universal ease of use, Braille dots are embossed on the control panel, and the stepped-level panel where the menu buttons are raised slightly higher for easy button selection. The NW-8PAM2 model also has the first voice message function in the industry, the “Oshiete-Button,” which guides users through procedural steps and tells them what to do if an error message is displayed on the panel.

(3) Another standard feature is “Triple Lint Filters” consisting of two large lint filters located in lower area of the washing tub and one upper lint filter.

## Washing-brush Built-in Washable Rotary Shaver



*Washing-brush built-in washable rotary shaver*

Earlier, Hitachi developed an original rotary shaving system based on the advantages of both “reciprocating (foil)” and “rotating” concepts in men’s electric shavers. Mass production of shavers based on Hitachi’s rotary shaving system first began in 1990. Hitachi’s rotary shaver looks like a “reciprocating (foil)” shaver. However, the shaving method is the rotating. Ten razor edges of the inner blade revolve vertically at a high speed enabling a closer, faster, and smoother shave.

The demand for washable electric shavers, which are easier to use and more hygienic has been increasing rapidly.

Responding to this demand, in 1998 Hitachi launched its washable rotary shaver based on a very unique concept of using a washing brush, made possible due to Hitachi’s rotary shaving system. The shaver can be thoroughly cleaned of hairs because the washing brush revolving at a high speed rakes out the hairs from the inner blades.

Last year, we launched a washing-brush built-in washable rotary shavers that can be thoroughly cleaned with only one hand. The head has two washing brushes that revolve at a high speed during rinsing. The brushes are separate from the inner blades and are not used in shaving. To rinse the shaver, just push the button at the side of the head. An outer blade pops up to around 1 cm, and the built-in washing brushes come in contact with the inner blades.

Turn on the shaver and let the water run through the space that appears after the blade pops up. The washing brushes in close contact with the inner blades revolve at a high speed and quickly and effectively rake out stubborn hairs and skin oil that causes bad smell. The users can easily clean the shaver without damaging the sharp edges of the shaver and affecting its cutting performance.

The body of the Hitachi washable rotary shaver conforms to the JIS waterproof standard and can be washed in whole. The outer blade can also be detached from the body and washed with running water or a household neutral detergent.

For a convenient use, Hitachi’s washing-brush built-in washable rotary shavers have the following functions.

The shaver can be used with or without the cord. For a safer use, the voltage can be transformed to DC 4 V through a power-supply adapter that automatically switches between 100-120 V and 220-240 V. In the center of the body we installed a large bright aqua-blue light for power-supply and battery-capacity indication. We are confident that using our washing-brush built-in washable rotary shaver, users will be able to enjoy comfortable and easy shaving and cleaning.

## New Vacuum Cleaner “Karuwaza Cordless” with a Cordless Main Unit and Power Head



*New vacuum cleaner “Karuwaza Cordless” Model CV-WD20*

Hitachi has put the new vacuum cleaner “Karuwaza Cordless” on the market, making a rechargeable function available to the conventional canister-type vacuum cleaner while eliminating the inconvenience of dealing with a power supply cord.

The main features are summarized as follows:

(1) The vacuum cleaner comes without a power supply cord, and eliminates troubles we have had when using the cleaner, such as connecting and/or disconnecting the power plug into and out of a receptacle, inserting and/or withdrawing of the power cord into and out of the main unit, and entangling the power cord during operation and storage. The cleaner can be concurrently recharged on a charging base on which both the main unit and power head can rest, and it can be used for up to 25 minutes on one charge. To operate it for a longer time, the power cord can be connected to an AC power inlet as well.

(2) The new model has an excellent, high-efficiency dust collecting system that is at least as good as that of conventional air cleaners. Many ventilating openings on the sides of main unit allow air currents to go gently upward around the main unit, so that fewer dust particles rise from the floor. This mechanism helps users to purify the air while cleaning a room.