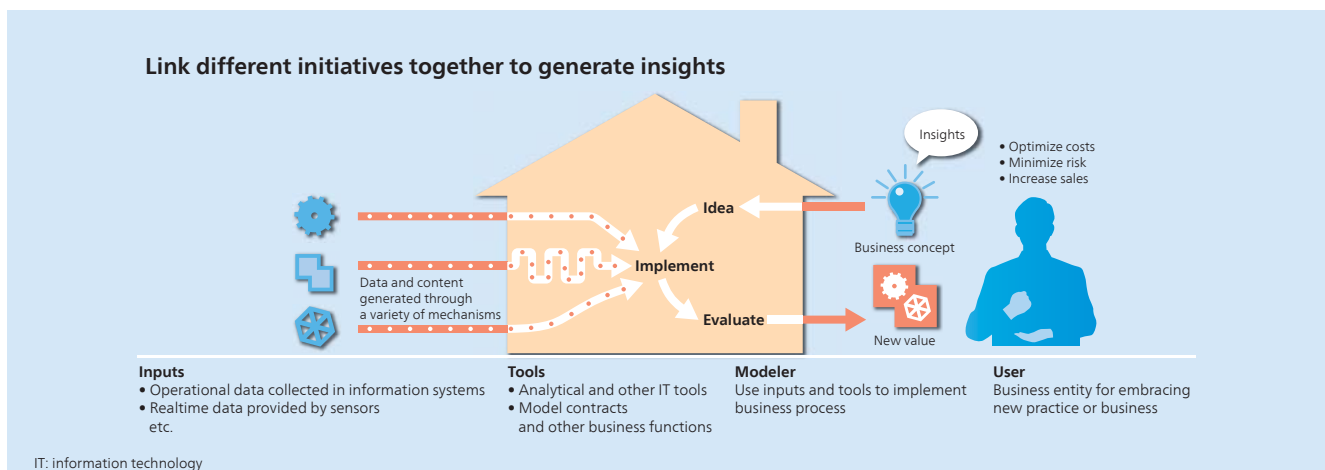


# Symbiotic Autonomous Decentralized Systems



## 1 Concept of symbiotic autonomous decentralization

### 1 Concept of Symbiotic Autonomous Decentralization —Symbiotic Approach Opens up Potential for Open Innovation—

Due to social change and technological progress, new value is created in this current era of open innovation by linking different systems together. A typical example might be a service for calling a taxi at short notice that works by combining smartphone user location data with a vehicle dispatch system.

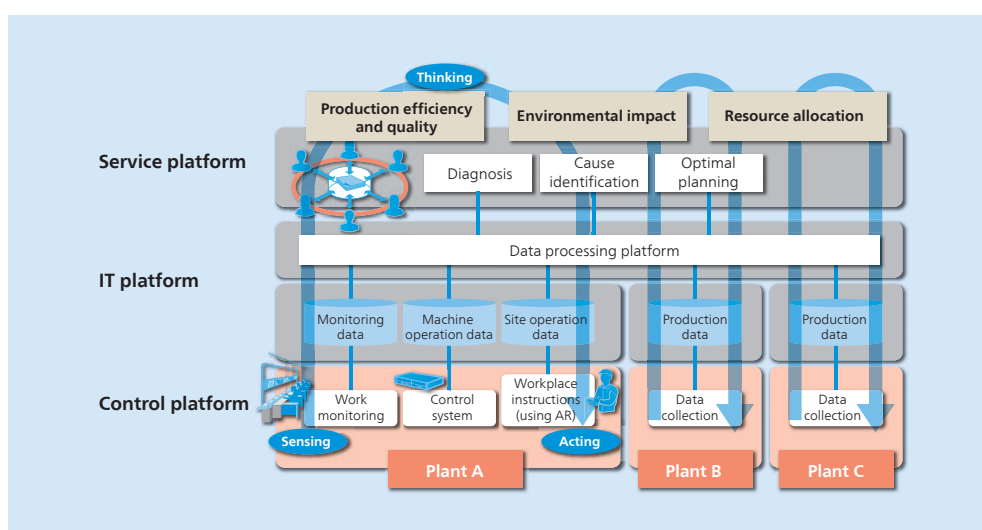
How this interconnection is achieved is key to the use of system interoperation to create innovative services, and it also requires secure processing via standardized interfaces based on defined data types. Also crucial is an environment that enables ideas to start small and then grow quickly through a process of trial and error.

The concept and methodology of symbiotic autonomous decen-

tralization are proposed by Hitachi as a way of achieving such innovations through collaboration. Hitachi provides ways of working together to generate insights into how to improve the key performance indicators (KPIs) for a customer's business so that open innovation with customers and other partners can be achieved through the approach of symbiotic autonomous decentralization.

## 2 Symbiotic Autonomous Decentralized Systems Architecture

With growing use being made of the Internet of things (IoT), especially in manufacturing, Hitachi is seeking to generate customer value through systems that interconnect in accordance with the symbiotic autonomous decentralized systems concept.



## 2 Symbiotic autonomous decentralized systems architecture

Hitachi has a track record of developing highly reliable and scalable control systems using autonomous and decentralized designs and deploying them in such fields as transportation and industry. The symbiotic autonomous decentralized systems concept extends this to the system level and seeks to achieve system-wide optimization by collecting various types of real-world data (sensing), utilizing it in big data analytics and formulating measures based on systems and operational knowledge (thinking), and then providing these proposed measures back to the field as feedback (acting).

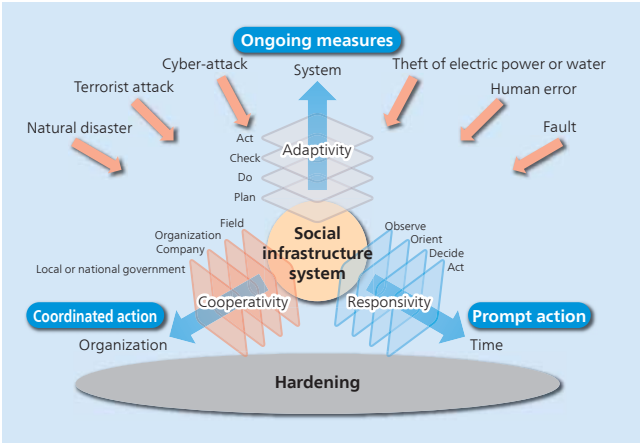
Achieving this involves integrating a wide range of technologies to satisfy customer needs, including the use of video and other new sensing techniques, big data platforms with the flexibility to handle diverse forms of data, big data analytics incorporating techniques such as artificial intelligence, and the use of augmented reality (AR) to provide feedback to the field.

### 3 Security in Symbiotic Autonomous Decentralized Systems

Along with relentless progress in industrial and social infrastructure systems, it is important that security also becomes more advanced.

To this end, Hitachi supplies a security solution for building symbiotic autonomous decentralized systems based on Hitachi system security concept. In addition to providing hardening (defenses) in compliance with IEC 62443 and other standards, the solution provides the adaptivity to implement the plan, do, check, act (PDCA) cycle for dealing effectively with ongoing change, the responsiveness to implement the observe, orient, decide, and act (OODA) cycle for responding promptly to unexpected incidents, and the cooperativity for implementing security through interoperation between different systems.

In addition to engineering such systems, Hitachi also supplies such products as controllers with Embedded Device Security Assurance (EDSA) certification, security gateways (GWs), one-way routers, systems for the detection and forcible removal of



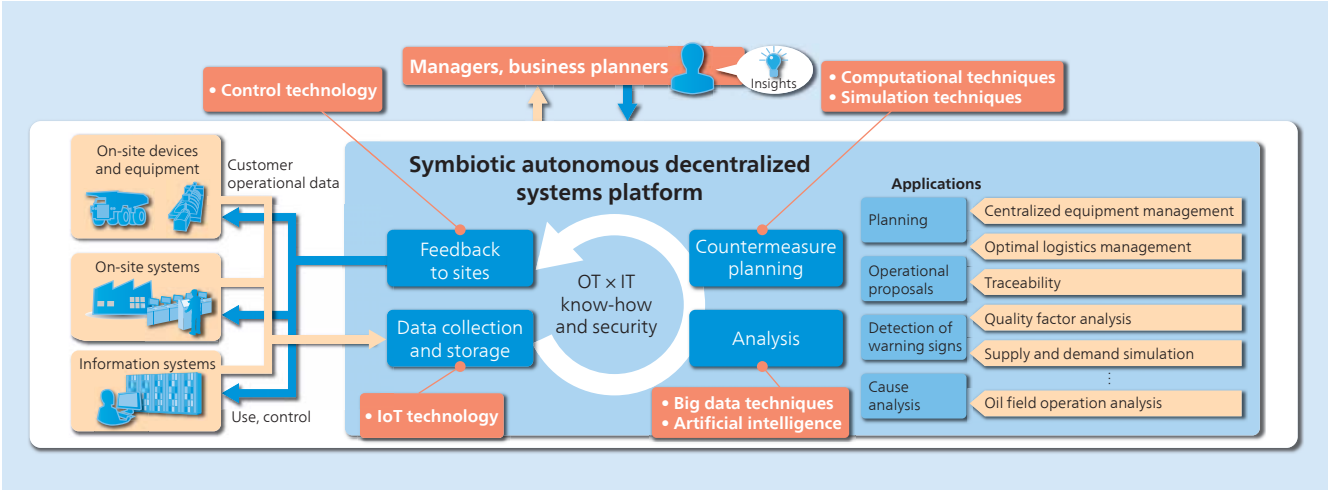
3 Security solution for social infrastructure systems (Hitachi system security concept)

unauthorized personal computers (PCs), and security monitoring and damage analysis services.

### 4 Symbiotic Autonomous Decentralized Systems Technology

Hitachi uses its symbiotic autonomous decentralized systems concept as a basis for encouraging open innovation and the timely creation of customer value by connecting autonomous systems together. Data collection and storage, analysis, countermeasure planning, and feedback are all important factors in achieving this. Data collection and storage use IoT technologies, analysis uses big data analytics (such as Pentaho) or artificial intelligence (such as Hitachi AI Technology/H), countermeasure planning uses simulation and other computational techniques, and feedback uses control technologies.

To accelerate the growth of its social infrastructure business, Hitachi intends to build common platforms that will allow it to put solutions together quickly using these technologies, products, and services, and to deliver them securely based on a combination of operation technology (OT) and IT know-how.



4 Symbiotic autonomous decentralized systems platform

# Transportation Systems



1 Series HB-E210 rolling stock

## 1

### East Japan Railway Company Series HB-E210 Traction Drive System

On May 30, 2015, East Japan Railway Company opened the Senseki-Tohoku Line in conjunction with a comprehensive upgrade to the Senseki Line. The Senseki-Tohoku Line was created by linking the Senseki Line, which uses direct current (DC) power, with the Tohoku Line, which uses alternating current (AC) power, through an interconnecting line (non-electrified). It provides express services between Ishinomaki and Sendai using the Series HB-E210 of hybrid rolling stock, which can operate on all different forms of electrification.

Hitachi manufactured and supplied a hybrid drive system for the Series HB-E210 that is the latest version of the systems used on the Series Kiha E200 and HB-E300. In addition to combining the output of the engine and lithium-ion batteries to provide regenerative braking, optimal engine operation, and an idling stop function, the system also features the ability to continue

operating as an electric locomotive even if the drive system batteries are unavailable. This new function is achieved by installing emergency batteries in the main converter that can be used to start the engine and generate power.

In the future, Hitachi intends to continue utilizing battery and engine-powered generator control technologies to satisfy the diverse requirements of railway operators.

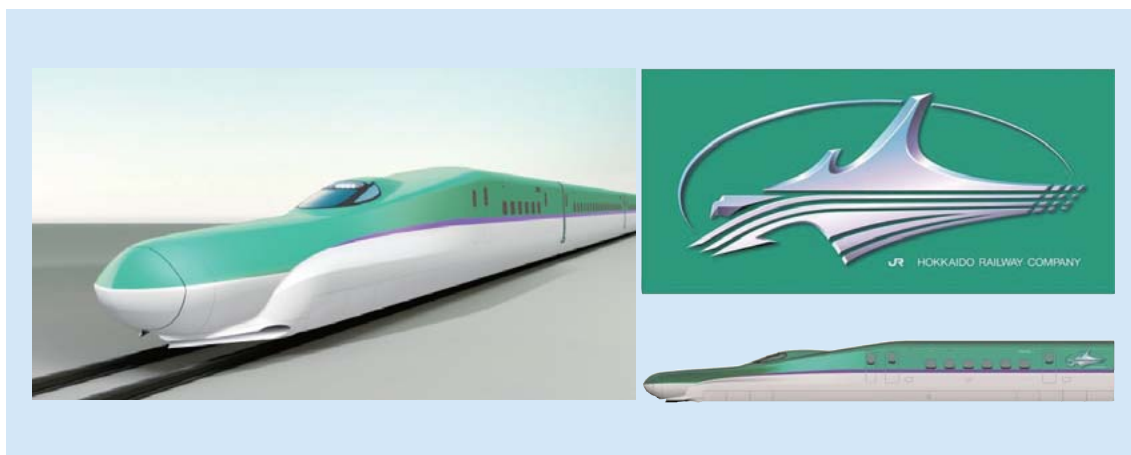
## 2

### Series H5 Shinkansen for Hokkaido Railway Company

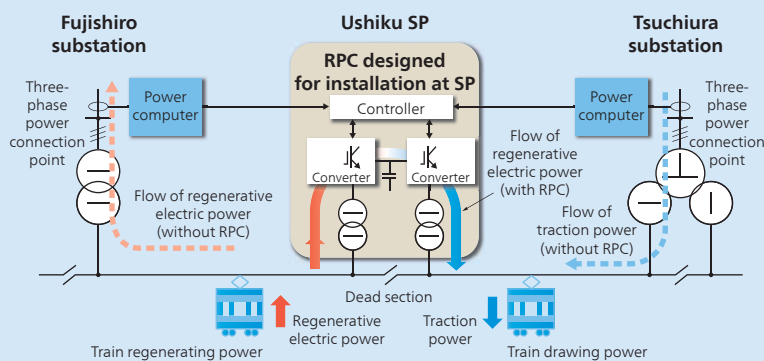
The Hokkaido Railway Company has introduced a Series H5 Shinkansen rolling stock (based on the existing Series E5) and is conducting operational trials in preparation for the opening in March 2016 of the Shin-Hakodate-Hokuto service of the Hokkaido Shinkansen.

The train will have a maximum speed of 320 km/h and operate at 260 km/h on the Hokkaido section and 140 km/h in the Seikan Tunnel. The exterior design of the rolling stock is based on the original Series E5 and incorporates features that are distinctive of Hokkaido, including the violet (“saika purple”) color. Similarly, the symbol designed to represent the rolling stock is based on a bird of prey (gyrfalcon) motif. The Series H5 Shinkansen incorporates a wide range of technologies and leading-edge equipment, with light-emitting diode (LED) lighting in the passenger cabins and barrier-free features that include large wheelchair-accessible toilets and multi-purpose rooms.

As the route includes the Seikan Tunnel, which links Hokkaido to Honshu (Mainland of Japan), the technologies used in the rolling stock include a constant speed control system in the traction drive to suit the gradient in the tunnel.



2 Series H5 rolling stock for Hokkaido Shinkansen (image of completed train) and the Series H5 symbol design



**3** Use of regenerative electric power by RPC designed for installation at an SP (left) and equipment in the RPC room at the Ushiku SP (right)

### 3 East Japan Railway Company RPC for Ushiku SP

A railway static power conditioner (RPC) developed and installed by Hitachi for the Ushiku sectioning post (SP) of the East Japan Railway Company's Joban Line entered service in March 2015. The purpose of the RPC is to take advantage of regenerative electric power.

As track sections fed by AC power are separated from each other by SP dead sections, it is not possible to transfer regenerative electric power between adjacent sections. Rather, to achieve this requires the installation of an RPC. The system is made up of the RPC and a power computer installed in the adjacent substation. Based on information sent via the power computer, the RPC reallocates excess regenerative electric power to other sections where rolling stock are drawing power. The RPC can transfer up to 5.3 MW (rated power: 1.3 MW) using a power converter equipped with insulated-gate bipolar transistors (IGBTs). It is also fitted with a reactive power compensator to cope with the fall in voltage when rolling stock are running on an extended section, thereby helping to keep trains operating reliably.

a remote personal computer (PC) and the addition of monitoring functions that include continuous monitoring and automatic checking.

A data logging function stores data such as the voltages and currents during faults to make the causes easier to identify.

Hitachi intends to continue working with customers to help keep trains running reliably.

### 4 Central Japan Railway Company Upgrade to Nishi-Sagami FC Distribution Panel

The distribution panels supplied by Hitachi for the No. 2 Shinkansen frequency converter at the Nishi-Sagami frequency conversion (FC) substation of the Central Japan Railway Company entered service in April 2015.

Prompted by the aging of the previous equipment, the project involved a complete replacement of the control and protection systems on the No. 2 frequency converter.

The adoption of digital control and protection systems not only makes the equipment more compact, it also improves functionality and reliability thanks to a function for entering settings from



**4** Upgraded protection relay panel





5 Dual 50-Hz/60-Hz control and protection system (left) and indoor GIS installation (right)

## 5

### Hokuriku Shinkansen Shin-Joetsu Substation

Key wayside equipment supplied for the Shin-Joetsu substation of the Hokuriku Shinkansen between Nagano and Kanazawa entered service in March 2015.

As the power supply between Nagano and Kanazawa is supplied by Tohoku Electric Power Co., Inc. (at 50 Hz) and by Chubu Electric Power Co., Inc. and Hokuriku Electric Power Company (at 60 Hz), a feature of this section of line is that, as with the existing line between Takasaki and Nagano, it uses electric power supplied at these two different frequencies. The Shin-Joetsu substation that supplies power to rolling stock is itself supplied by Tohoku Electric Power Co., Inc. via a 154-kV/50-Hz line. It is also capable supplying rolling stock at 60 Hz using power drawn from adjacent substations. Accordingly, electrical equipment for the feeder sections is designed to operate at both 50 Hz and 60 Hz. The feeder protection system supplied as part of this project was designed to provide protection in the event of a fault, with a monitoring system able to work at both 50 Hz and 60 Hz that was developed jointly with the West Japan Railway Company and the Japan Railway Construction, Transport and Technology Agency. The Shin-Joetsu substation uses gas-insulated switchgear (GIS) to minimize equipment size and is installed indoors to prevent snow-damage.

## 6

### Adoption of ATOS on Yokohama Line and Commencement of Operation

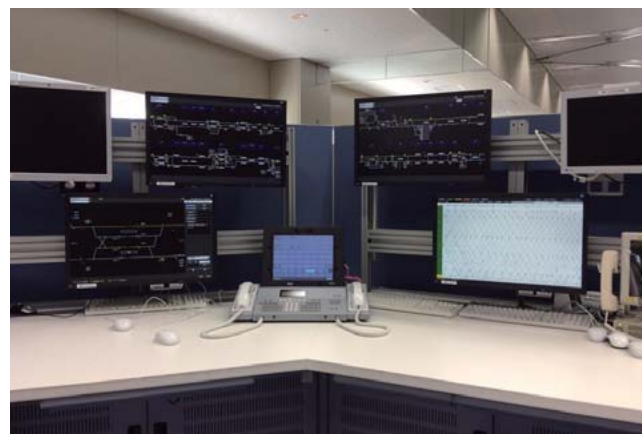
The Autonomous Decentralized Transport Operation Control System (ATOS) of the East Japan Railway Company operates on high density railway lines in the Tokyo region.

The system was installed on the Yokohama Line from Hachioji to Higashi-Kanagawa Station in July 2015. As ATOS operation on the Chuo Line and Keihin-Tohoku/Negishi Line had already commenced when the system entered use at these terminal

stations on the Yokohama Line, system migration involved a mix of existing and new stations, with a staged switchover being adopted for things like train scheduling to achieve a smooth transition without interfering with the existing system or railway operations. The adoption of ATOS on the Yokohama Line has further improved the safety and reliability of transportation in the Tokyo region.

Prior to the installation of ATOS, graphic displays\* (GDs) were installed at Yokohama Line Hashimoto Station in June 2015. This improved the efficiency of station operations, including the entry of changes to incoming and outgoing schedules, by making it possible to input train schedules in timetable data in place of the previous operation, which used character-based screens.

\* Terminals equipped with a function for entering schedule changes using timetable data like those used on the traffic supervision desks at a control center.



6 Control desk for Yokohama Line



7 East Japan Railway Company's onboard track inspection system

## 7 East Japan Railway Company Commencement of Operation of Onboard Track Inspection System (Yamanote Line, Chuo Line, and Keihin-Tohoku Line)

A track inspection system for installation on operating trains that was supplied for use on the Yamanote Line, Chuo Line, and Keihin-Tohoku Line, major lines in the Tokyo region operated by the East Japan Railway Company, commenced operation during FY2015.

A feature of the system is that it uses an inspection unit installed under the floor of operational rolling stock to make high-frequency measurements of track displacement at the same 0.1-mm degree of precision as the dedicated inspection cars used to make periodic measurements in the past. The measurement data is sent in realtime by a wireless communication system to a central management system that has connections to terminals

located at the maintenance depots. This enables track monitoring to be performed from any depot. In addition to making a major contribution to ensuring the even safer operation of railway services, track monitoring using the new system also has the potential to help make track maintenance even more efficient than in the past.

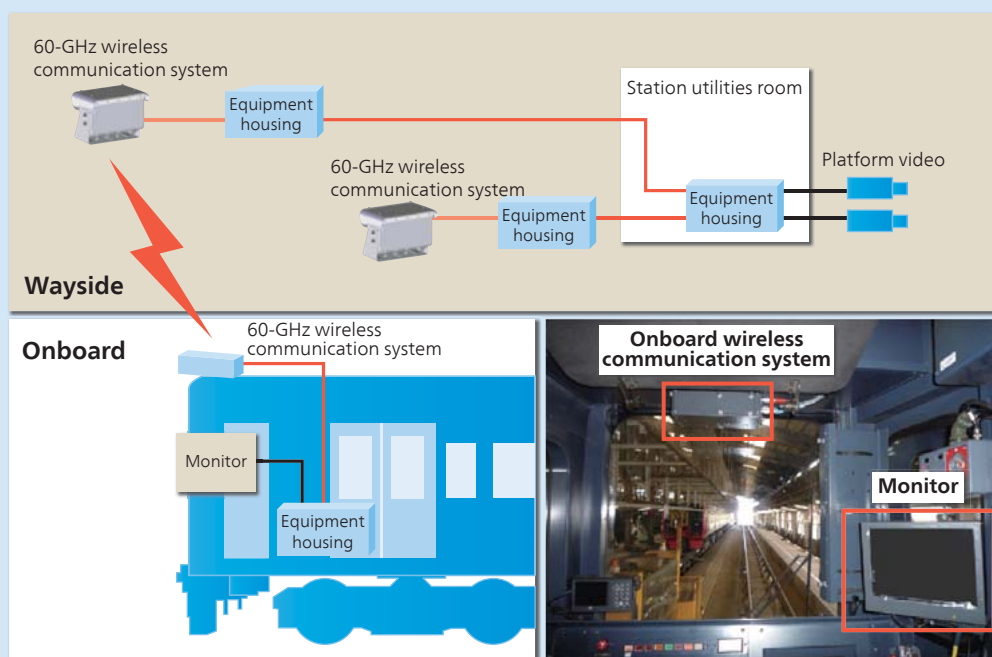
In the future, Hitachi intends to extend deployment of the system to major lines in the Tokyo region and to regional lines.

## 8 Kyushu Railway Company Support System for Single-driver Trains on Chikuhi Line

As part of an upgrade due to the aging of existing equipment, a system used by Kyushu Railway Company on its Chikuhi Line to support train operation by a single driver was switched from its current 2.4-GHz band communication system to a 60-GHz millimeter band system. The system ensures passenger safety and reliable operation of single-driver trains by displaying images of the platform to the driver on their onboard monitor screen.

To satisfy the system requirements, which included realtime image display and uninterrupted display until the rear of the train fully clears the platform, the support system was implemented in a way that ensured seamless display. This was done by upgrading to a video communication system with low-latency that provides realtime display, and works by polling multiple wayside wireless base stations to perform progressive handover from one station to another.

(Commencement of operation: April 2015)



8 Configuration of Kyushu Railway Company system for supporting train operation by a single driver on the Chikuhi Line

# Public Sector Systems



1 Monitoring and control system for water treatment plant

## 1 Monitoring and Control System for Water Treatment Plant

Hitachi has supplied a monitoring and control system for a water treatment plant that uses dual-configuration controllers for electric power distribution, water treatment, and water distribution equipment, and centrally located dual data servers, monitoring and control terminals, and large monitors. The system is configured to operate the plant and present an overview of its

status by providing a separate control screen for each item of equipment and consolidating the display of calculation details and settings input.

The system is equipped with functions that support reliable and economical operation, including a water distribution planning system that uses demand prediction control based on actual past data and a quasi-optimal routing system (QRS) to plan flow settings both on and off site, as well as functions for sending settings to each controller, auto-generating water distribution plans 48 hours in advance, and simulation.

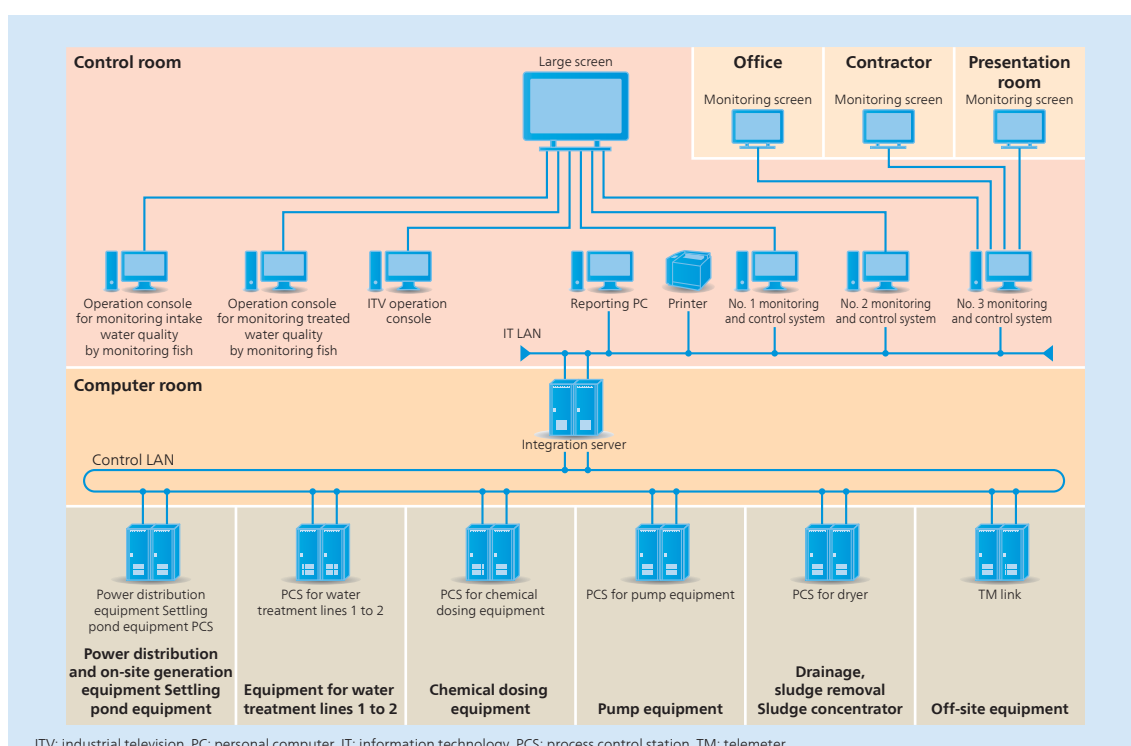
(Delivery date: March 2015)

## 2 Central Monitoring and Control System for Arai Wastewater Treatment Plant of Koriyama City Water Bureau

The Arai Wastewater Treatment Plant commenced operation in 1997 with a capacity of 21,000 m<sup>3</sup>/d. It was the first such facility in Tohoku to adopt an advanced water treatment technique based on ozone and activated carbon. The plant capacity is now 42,000 m<sup>3</sup>/d and it mainly supplies the eastern parts of Koriyama City in Fukushima Prefecture. Hitachi recently undertook a full replacement of the plant's central monitoring and control system.

The main features are as follows.

(1) The system uses a client-server architecture and a dual configuration for monitoring and control equipment (servers) to



## 2 Central monitoring and control system for Arai Wastewater Plant of Koriyama City Water Bureau

improve reliability.

(2) High-speed communication is provided by connecting controllers to a control local-area network (LAN).

(3) All of the operation consoles with mini-graphics panels were removed and replaced with liquid crystal display (LCD) monitors.

(4) The use of networking equipment allows monitoring to also be performed from offices or a presentation room.

(Commencement of operation: March 2015)

### 3 Central Monitoring and Control System for Izumi Water Treatment Plant of Fukushima Prefecture Development Bureau for Public Utilities

Iwaki City in Fukushima Prefecture has four industrial water supplies. With a maximum capacity of approximately 1,260,000 m<sup>3</sup>/d, these are playing an important role in the recovery of industrial activity.

A system recently supplied by Hitachi to the Izumi Water Treatment Plant performs central monitoring and control of the industrial water supplies for the Iwaki, Nakoso, and Onahama districts. The main features are as follows.

(1) The system improves reliability using a client-server architecture, with a dual configuration for servers and four-fold redundancy for the control LAN (2 × dual rings).

(2) High-speed communication is provided by connecting controllers directly to a control LAN.

(3) It reduces space requirements through the removal of control room desk controllers, instead providing a human interface for monitoring and control of master telemetry stations for off-site equipment.

(4) It replaces the operation panels in the sludge processing

building with notebook PCs (clients) for sludge equipment monitoring that are connected to the control LAN at two points in the sludge processing building.

### 4 Monitoring and Control System for Niwakubo Water Purification Plant of Osaka Municipal Waterworks Bureau

The Niwakubo Water Purification Plant of the Osaka Municipal Waterworks Bureau started supplying water to Moriguchi City in the north of Osaka in November 1957 with a capacity of 120,000 m<sup>3</sup>/d drawn from the Yodo River. The current configuration is made up of three water intake and distribution systems (14 intake pumps and 13 distribution pumps), 64 filtration basins, and advanced water treatment systems, providing a capacity of 800,000 m<sup>3</sup>/d. It was the second water treatment plant to commence operation in Osaka City.

Hitachi recently replaced the central monitoring and control system with an integrated monitoring and control system designed to improve reliability and optimize water distribution.

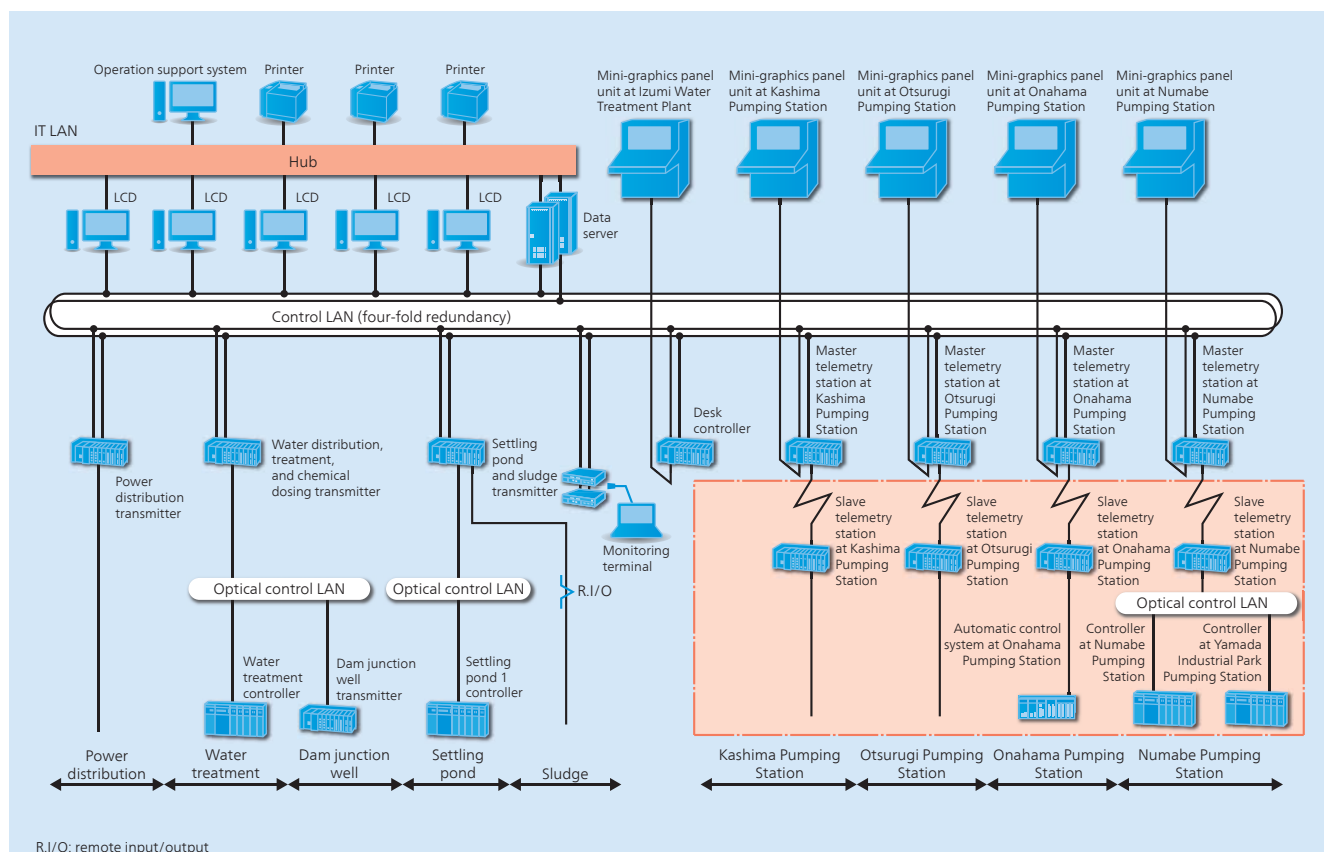
The main features are as follows.

(1) The system uses a client-server architecture and a dual configuration for servers to improve reliability.

(2) It achieves further improvement in reliability by using a three-way configuration for plant control equipment (dual main controllers and a single backup controller).

(3) The system achieves optimal operation of water distribution using demand prediction data generated by the integrated water distribution system at Kunijima Water Purification Plant.

(Commencement of operation: April 2015)



3 Central monitoring and control system for Izumi Water Treatment Plant of Fukushima Prefecture Development Bureau for Public Utilities





4 Control center of monitoring and control system for Niwakubo Water Purification Plant of Osaka Municipal Waterworks Bureau

## 5 Monitoring and Control System for Isaza Intake Pumping Station of Kitakyushu City Water and Sewer Bureau

The Isaza Intake Pumping Station has the important task of supplying water from the Onga River to various water distribution facilities in Kitakyushu City (Fukuoka Prefecture). As the monitoring and control system used to operate the station had been in service for more than 15 years and was becoming difficult to maintain due to problems such as age and spare parts availability, a project was undertaken to replace it.

Whereas the Isaza Intake Pumping Station had previously been operated manually based on the experience and judgment of the operators, the replacement project included installation of LCD monitoring and control units (industrial PCs) and controllers that perform automatic control of water intake in accordance with the quantity of water to be supplied to each water distribution facility.

Furthermore, the water intake station can be monitored remotely from the monitoring and control system at the Ano

Water Purification Plant (supplied by a different vendor). As failure of communications with the Ano Water Purification Plant has a significant impact on operation, the configuration of the communication controller uses dual central processing units (CPUs). Also, the control network uses optical communications, including both input and output (I/O) devices, to ensure reliable communications without being vulnerable to lightning or electro-magnetic noise.

(Commencement of operation: March 2015)

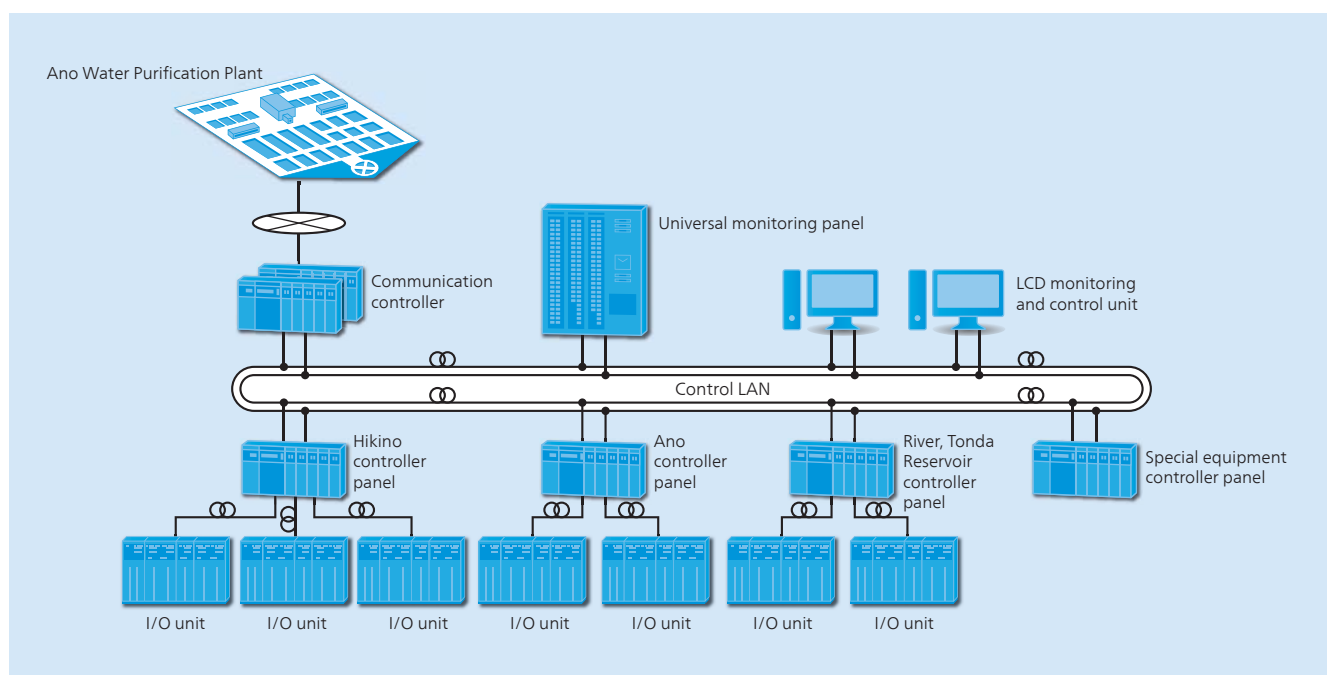
## 6

### Sea Level Reporting System

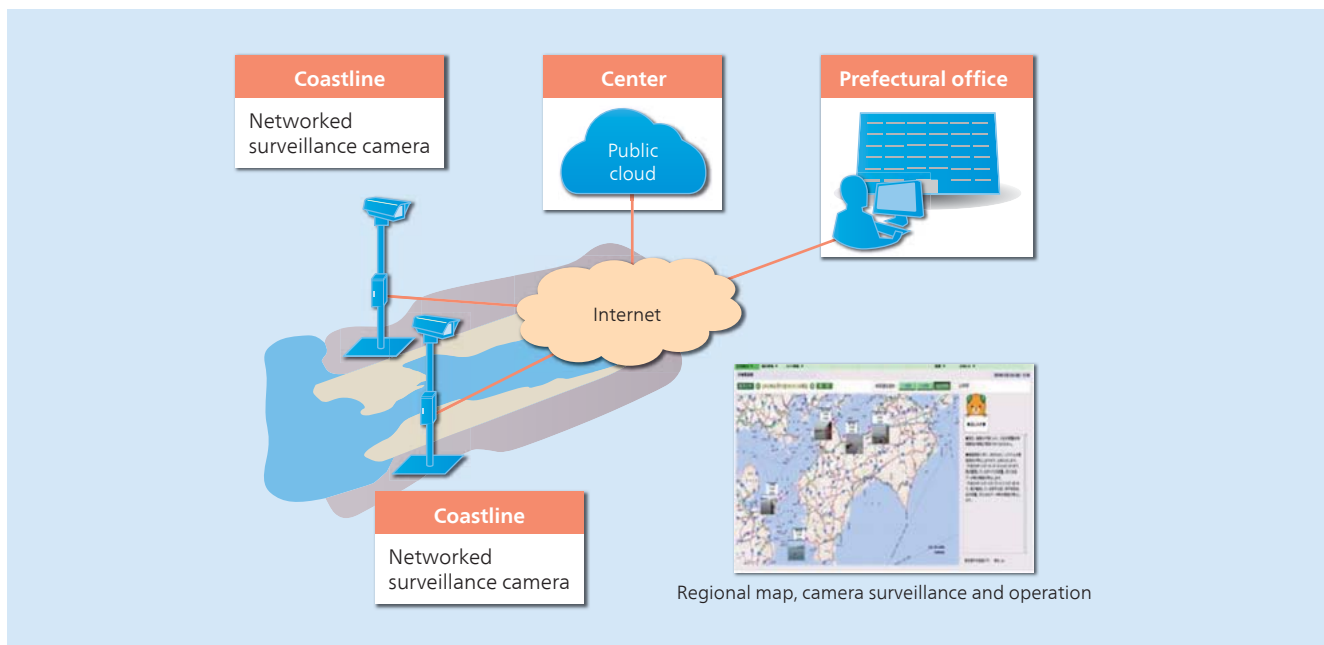
As the height of a tsunami when it strikes land tends to be higher than the wave height observed in open water, it is essential that information be provided in a manner that is timely and accurate for the region concerned. The requirement is to implement an information collection and distribution system with minimal installation and maintenance costs that can reliably collect data from the equipment being managed and deliver it to the community.

To meet this objective, the system uses cloud-based telemetry. Furthermore, because the height of a tsunami when it strikes land tends to be higher than the wave height measured out at sea, the system was designed to provide useful civil defense information by consolidating sea level sensors along the coast of the prefecture to collect and supply sea level information in realtime. As having people go out and visually confirm sea levels can be difficult, such as when high tides occur at night, providing web cameras, sea levels, and other information on a reliable and routine basis can make the information available for civil defense use.

In the future, Hitachi intends to draw on know-how from the implementation of this system to help ensure safe and secure communities while also satisfying a wide range of customer needs.



5 Block diagram of monitoring and control system for Isaza Intake Pumping Station of Kitakyushu City Water and Sewer Bureau



6 Overview of Ehime Prefecture sea level reporting system

## 7 Efficient Nitrification Control System Incorporating ICT (Technology Verification by B-DASH Project)

Since FY2014, as part of the Breakthrough by Dynamic Approach in Sewage High Technology (B-DASH) Project of Japan's Ministry of Land, Infrastructure, Transport and Tourism, Ibaraki Prefecture and Hitachi have been working on the "Demonstration of Efficient Nitrification Control with ICT," a contract research initiative of the ministry's National Institute for Land and Infrastructure Management. The research is trialing a nitrification control system that combines energy efficiency with the maintenance of good water quality at the Kasumigaura Sewage Treatment Plant in Ibaraki.

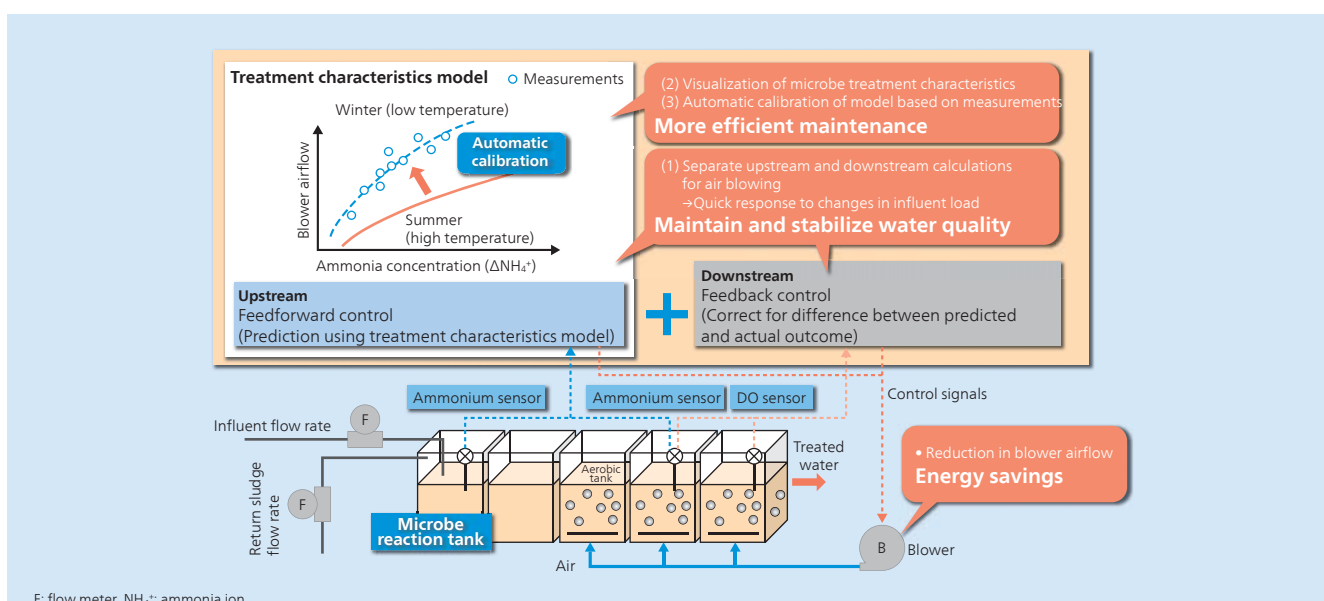
In addition to a downstream dissolved oxygen (DO) sensor, the control system also incorporates ammonium sensors located midway along and upstream of the aerobic tank. The system is

designed to maintain water quality, improve energy efficiency by reducing air blowing, and enable more efficient maintenance, with functions that use these sensors to combine feedforward and feedback control, display process characteristics, and automatically calibrate control parameters.

The FY2014 trials demonstrated a 14% reduction in blower airflow compared to constant-DO control while achieving a mean ammonia concentration in the treated water of 0.3 mg-N/L (target: 1.0 mg-N/L or less). The trial is continuing in FY2015 to assess reliability over the long term, and is scheduled to end in March.

## 8 Precision Farming Demonstration Project in Australia Using Quasi-Zenith Satellite System

Along with Hitachi Zosen Corporation and others, Hitachi was



7 Overview of nitrification control system being trialed as part of B-DASH Project



8 Use of self-steering tractor to spread fertilizer on a crop farm in Australia

commissioned by the Ministry of Internal Affairs and Communications in FY2014 to conduct a study on the effective use overseas of advanced positioning signals from Japan's Quasi-Zenith Satellite System. This involved a demonstration project on the use of the Quasi-Zenith Satellite System for precision farming in Australia.

The demonstration project uses a new precision standalone positioning system to send highly accurate position corrections to farm tractors on the signals from the L-band experiment (LEX) quasi-zenith satellite. This succeeded in obtaining tractor locations to an accuracy of  $\pm 5$  cm and driverless operation along rows of crops. The project also used the geographic information cloud service of Hitachi Solutions, Ltd. to collect self-steering data from the tractors and crop growth sensor data and present it on an on-screen map. Potential uses include providing this data to the farmer, or improving the efficiency of agricultural production and agricultural machinery management through the use of self-

steering.

Along with use in commercial agriculture, in the future Hitachi intends to operate businesses that utilize precise positioning techniques in other industries and regions.

## 9

### Iwanuma City Fatigue Measurement System

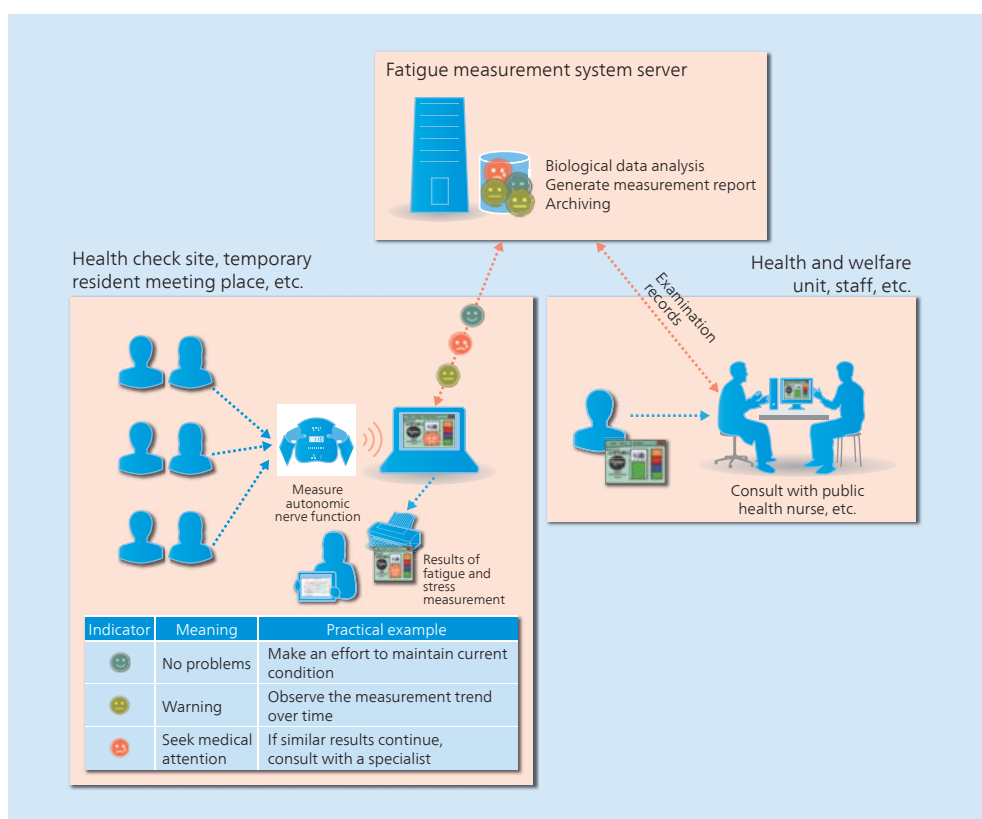
Iwanuma City in Miyagi Prefecture introduced a fatigue measurement system in April 2015. The system is used for resident health checks to measure levels of fatigue and stress. Made up of an autonomic nerve measurement device\* and the fatigue measurement system server, the system performs analyses and generates reports using an analytical function from Fatigue Science Laboratory Inc. that runs on the server.

Measurement is simple to perform. The examinee inserts his/her left and right forefingers into the autonomic nerve measurement device for two to three minutes while it records the electrocardiogram and pulse waveforms that provide the basis for the analysis. The report gives the examinee's age in terms of their autonomic nerve function, heart rate variability, and the balance between their sympathetic and parasympathetic nerve, and provides a three-level assessment of either "OK," "Warning," or "Seek medical attention." This information can prevent mental health risks and assist with early detection.

In the future, Hitachi intends to continue deploying mental healthcare solutions like this to local governments, educational institutions, and companies.

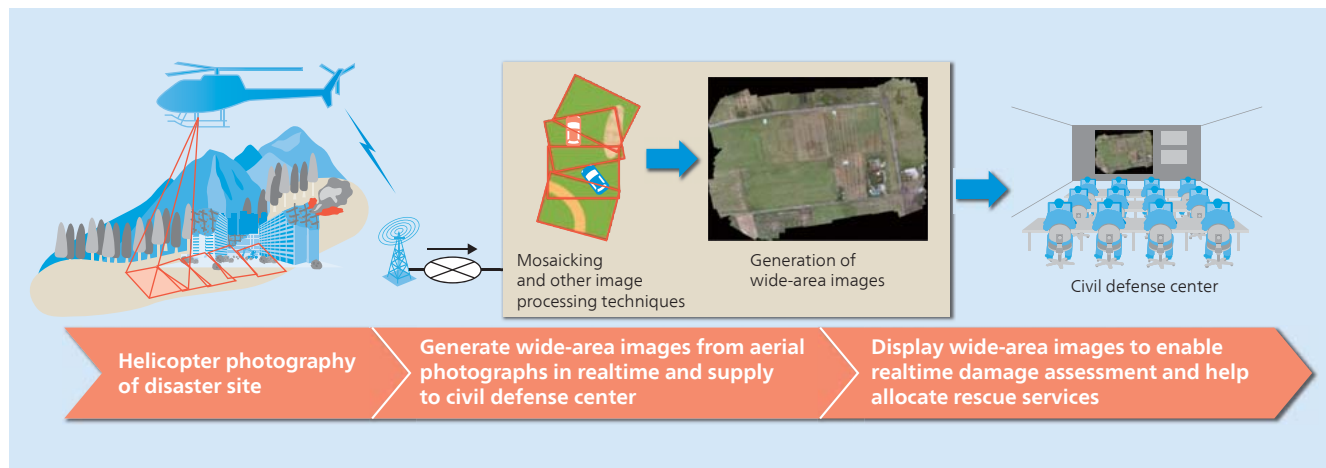
[Hitachi Systems, Ltd. (implementation of fatigue measurement system)]

\* Developed by Fatigue Science Laboratory Inc.



9 Diagram of fatigue measurement system operations

# Security Technologies for Social Infrastructure



1 Realtime aerial image analysis system

## 1

### Realtime Aerial Image Analysis System

A rapid and appropriate first response to earthquakes and other large natural disasters is essential, including determining the level of damage in the immediate aftermath, sharing information, and allocating rescue services. While images from helicopters or small unmanned aerial vehicles are currently used for damage assessment, it can be difficult to quickly identify the physical location of an image and how it relates to the surrounding area. In response, Hitachi has developed a realtime aerial image analysis system that can generate wide-area images from photographs taken by helicopters and other sources.

The system generates precise images from aerial photography in realtime by using a mosaic technique along with distortion correction, techniques for minimizing position alignment error, and so on. The ability to convert large quantities of image data to compact image information means that civil defense agencies can share damage assessments among themselves to assist with achieving a rapid and appropriate first response.

Hitachi intends to contribute to society by supplying disaster prevention solutions that keep people safe and secure, not only in Japan, but also in other disaster-prone regions.

## 2

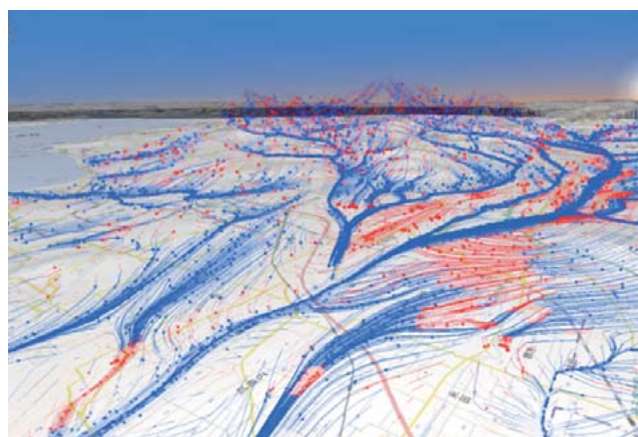
### Water Cycle Simulation Services

Following the Basic Plan on Water Cycle Policy cabinet decision of July 2015, national and local governments and other agencies are undertaking appropriate groundwater management for each river basin. In the future, Hitachi intends to supply water cycle simulation services that provide watershed analysis and visualiza-

tion for use in implementing the Basic Plan on Water Cycle Policy. Hitachi is also working to supply services for appropriate groundwater management globally.

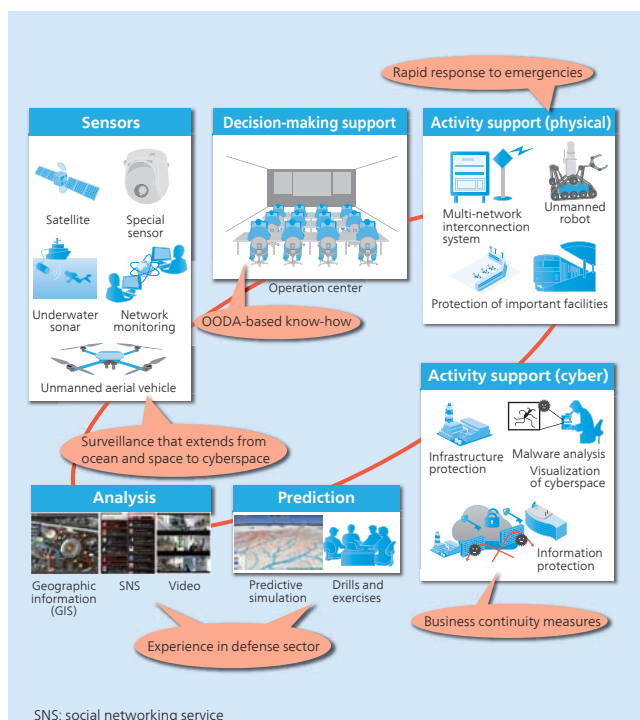
The water cycle simulation services include simulation techniques that fully combine and analyze both surface water and groundwater, and visualization techniques that provide quick and intelligible display of the analysis results. The simulation techniques consider interactions between surface water and groundwater and enable an analysis of mechanisms for the movement of pollutants and other substances. The visualization techniques can display large amounts of time-series data for above and below ground generated by the simulations, provide spatial totals, and plot data at high speed in accordance with the display scale.

With these features, it is anticipated that the service will provide even sophisticated assessments of the current situation and predictions of the future for water resources and the water cycle.



2 Visualizing surface water and groundwater flow (blue lines: surface water flow, red lines: groundwater flow)





**3** Providing a security solution for the entire social infrastructure

### 3

#### Wide-area Surveillance and Security Solution

Hitachi uses Hitachi system security concept, which focuses on measures that are adaptive, responsive, and cooperative, to deal with security requirements for protecting social infrastructure from threats such as natural disasters, cyber-attacks, and terrorism, and supplies a wide-area surveillance and security solution that provides appropriate ongoing measures in accordance with the International Organization for Standardization (ISO) 22320 standard for emergency management.

Specifically, it performs multifaceted monitoring of social infrastructure by using satellites, unmanned aerial vehicles, network monitoring, and other sensors to assess the ever-changing situation in both the physical and cyber realms. Along with using unmanned vehicles, security gates, and so on to provide physical support for activities, this includes analyzing and predicting

information using geographic information systems (GISs), analyzing image, and simulation techniques. It provides rapid and accurate decision-making support, including the provision of know-how based on the observe, orient, decide, and act (OODA) process.

It also supports prompt action through the automatic detection of warning signs identified by realtime processing of large amounts of collected monitoring data.

The system can be configured and installed quickly thanks to a flexible choice of hardware configuration based on the nature of the operation and existing equipment.

### 4

#### Multi-network Interconnection System for Use in Social Infrastructure Security

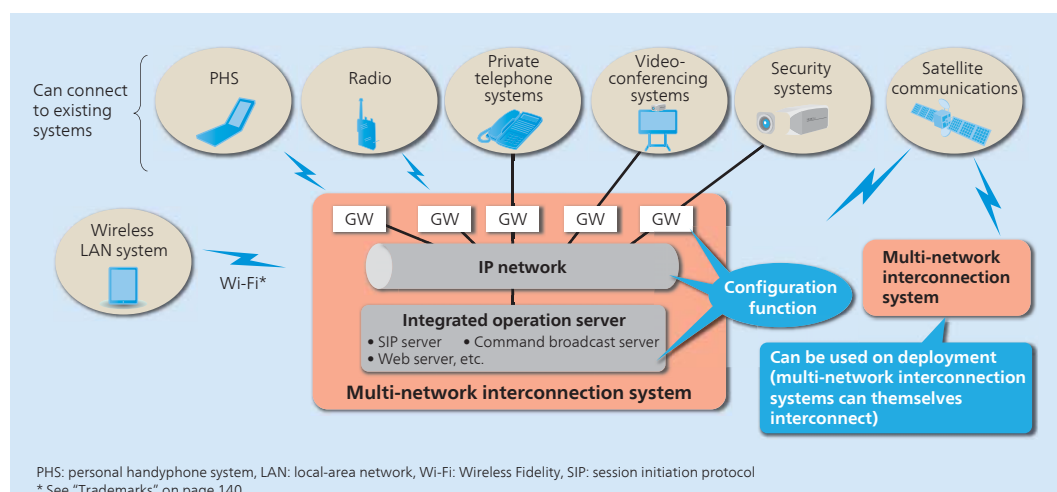
A breakdown in communications during a major disaster and the associated complications and confusion regarding information are obstacles to taking prompt action to limit damage.

This reaffirms the importance of ensuring that robust communication methods are available during a major disaster.

In response, Hitachi supplies a multi-network interconnection system that utilizes technology from the defense sector to provide means of communication that are suitable for use during a major disaster.

The system combines existing infrastructural communication equipment with other forms of wireless communication such as mobile phones and transceivers to make wide-area voice and data communications available simply and quickly. The system uses gateways that perform conversion to Internet protocol (IP) connections to provide seamless calls between telephones or over radios that do not normally support phone calls, including proprietary communication protocols like those used on transceivers for identifying devices from their frequency band.

Autonomous and portable for outdoor use, the system supports communications during a major disaster and at places that lack a communication network (such as at a worksite or inside a tunnel) by establishing a simple and proprietary communication infrastructure from a fragmented communication network or on mountains or remote islands.



**4** Image of using the multi-network interconnection system to connect existing communication infrastructure

# Elevators



**1** Elevator car (top) and image of different types of internal lighting (white light versus the color produced by an incandescent light bulb) (bottom)

## 1 New Model Attuned to Human Behavior in Keeping with the Core Concept of Hitachi Elevators

In September 2015, Hitachi announced a conceptual model for elevators that was developed to implement its new core concept that was formulated for its elevator and escalator product services with the aim of supplying systems that are compatible with human behavior.

In addition to conventional functions for safety, security, and comfort, this elevator uses comforting elevator car designs with minimal corners and rounded lines so as not to discourage passengers from leaning against them. It also uses liquid crystal displays (LCDs) with a portrait orientation for ease of viewing to display information in a way that makes it easier for passengers to visualize the movement of the elevator to their intended floor by giving an intuitive indication of the current location. Another function adjusts the lighting color to suit the time of day to provide a sense of comfort in the elevator car by conveying impressions such as crispness or warmth.

In keeping with this concept, Hitachi intends in the future to develop functions and services with a high degree of added value so that users can feel confident about making regular use of

elevators, and to deploy products throughout the world that incorporate these functions and services.  
(Hitachi Building Systems Co., Ltd.)

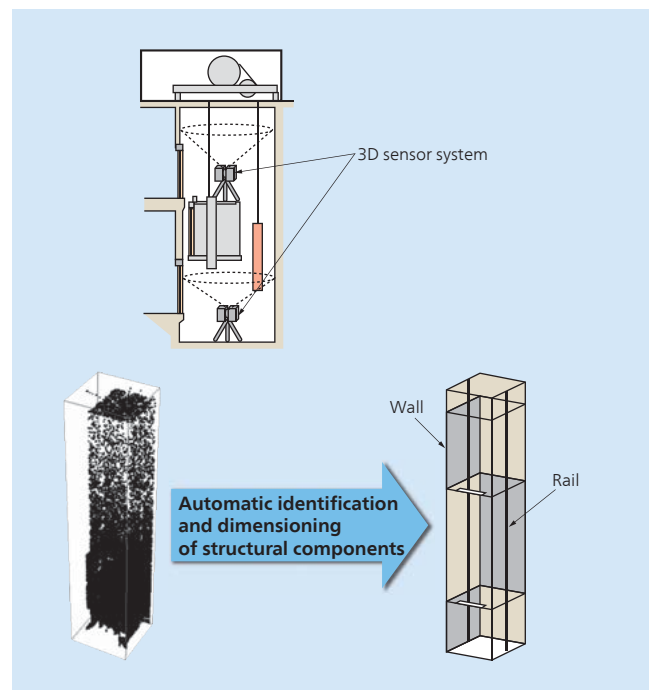
## 2

### 3D Site Survey System for Elevator Overhauls

Hitachi has developed a three-dimensional (3D) site survey system that significantly reduces the time taken from the site survey to the design work stage of elevator overhaul projects, and shortens the lead time for preparing work quotations. The system entered full-scale operation in April 2015. This significantly reduces the amount of time elevators have to be shut down to perform a site survey and shortens by 80%\* or more the total survey and design time required to prepare a work quotation, while also improving measurement accuracy and design quality.

The main features of the system are as follows.

- (1) Adopts a 3D sensor system to eliminate the need for manual dimension measurements, improves accuracy by eliminating measurement errors while also causing less user disruption by significantly shortening the time the elevator needs to be shut down (from 90 to 30 minutes).
- (2) Enables the dimensions of walls, rails, and beams to be determined automatically by using a newly-developed algorithm that automatically identifies these structural components from 3D



**2** Image of elevator shaft being measured using a 3D sensor system (top) and a depiction of the automatic calculation of dimensions from measurements (bottom)

measurements. This has shortened the time it takes to prepare drawings on a computer-aided design (CAD) system from four hours to about 30 minutes.

(Hitachi Building Systems Co., Ltd.)

\* Sum of the reduction in time an elevator is shut down for survey and the reduction in design time.

### 3 Advances in Remote Maintenance System and Wider Range of Models Covered by Remote Maintenance

Launched in April 2015, a new remote maintenance system was developed by Hitachi in tandem with the commencement of operation of the new 2014 models of its standard elevators.

The new remote maintenance system has undergone rigorous improvements in maintenance quality, featuring more accurate measurement and a wider range of measurements than the previous remote intelligent diagnostics unit, and has been enhanced to the point where it can detect small changes that occur in equipment such as brakes or door open/close mechanisms, etc. prior to problems. The new remote maintenance system is made up of products and services that improve elevator toughness, while also helping achieve a quick recovery in the event of a major disaster through its use in conjunction with an automatic diagnosis and recovery system, which uses a Long Term Evolution (LTE) communication link to intervene in operation in response to emergency earthquake warnings and performs automatic elevator diagnosis and recovery after seismometer operation halts.

In the future, Hitachi intends to use this technology to expand the coverage of remote maintenance through deployment in other products such as high-speed custom elevators or Hitachi's modernization package elevator overhaul offering. Hitachi also intends to continue providing safety and security to all building users, with the aim of being the world leader in maintenance quality, by expanding the use of the new remote maintenance system to China and other Asian markets.

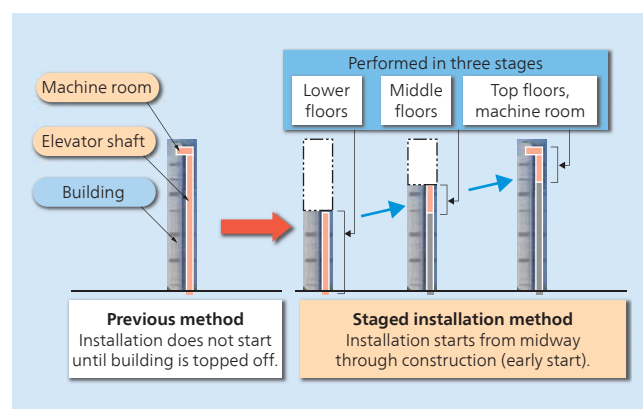
(Hitachi Building Systems Co., Ltd.)

### 4 Technique for Staged Installation of Elevators in Ultra-high-rise Buildings

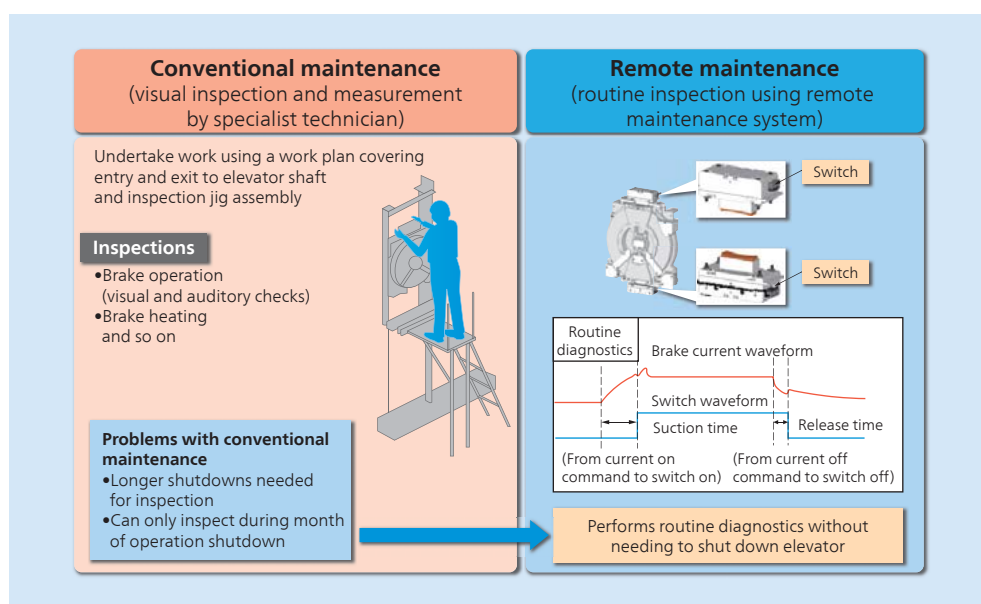
Hitachi is working to improve the quality of installation and maintenance by overseas escalator and elevator companies. Particular effort is going into quality improvement and shorter work times for the installation of elevators in ultra-high-rise buildings in China. Hitachi Elevator (China) Co., Ltd., the company that manages Hitachi's escalator and elevator business in China, has introduced a technique it developed for the staged installation of ultra-high-rise elevators.

The new technique involves starting installation in the lower part of the building from an intermediate floor prior to construction reaching the top floor. By starting the work earlier and shortening the installation time, elevator installation is completed at an earlier stage than with previous methods. This is appreciated by customers because it makes the elevator available for transporting construction materials and workers several months earlier than otherwise. In addition to improving the safety and quality of installation work, it also reduces worker workload.

Hitachi intends to adopt the new staged installation method for elevators as standard practice in buildings that are constructed to a height of 200 m or more (about 40 floors).



4 Overview of technique for staged installation of elevators in ultra-high-rise buildings



3 Brake inspection

# Industrial Equipment and Systems

New finger vein authentication terminal  
(model: FVA-100)



**Finger-only authentication made possible**  
by higher accuracy and faster speed  
**Provides improved 1:N authentication\* performance**

Prevents impersonation  
Avoids problem of forgotten or lost cards  
Avoids problems with contamination  
Reduces cost of issuing and recovering cards

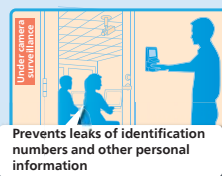
Expands availability of tighter security and greater convenience through card-less  
"finger-only" authentication



Service entrance



Food processing plant



Prevents leaks of identification numbers and other personal information

Supports My Number national identification system

\* Authentication of a presented finger vein pattern from a database of N fingers.

## 1 New model FVA-100 finger vein authentication terminal

### 1

#### Access Control System Using New Finger Vein Authentication Terminal

Finger vein authentication is mainly used for access management in situations such as server rooms that demand a high level of security. However, because of the inconvenience of having to issue and recover cards, the risk of their being forgotten or lost, and, in the case of factories, the potential for them to be a safety hazard or source of contamination if worn around the neck, recent times have seen growing demand for authentication based on the user's finger alone.

In response, Hitachi has developed the new model FVA-100 finger vein authentication terminal that features significantly improved authentication performance using only a user's fingers, reducing the number of instances of incorrect acceptance to 1/15 of the previous method\*<sup>1</sup> when used for successive authentication\*<sup>2</sup> and a high authentication speed of 10,000 fingers/s (three times previous method\*<sup>1</sup>). The first access control system fitted with the new terminal is used to control between one and 256 doors and is already on sale.

In the future, Hitachi intends to satisfy growing demand for tighter security and greater convenience, and to make an even greater contribution to creating a safe and secure society, by using the new terminal in applications such as cloud-based building facilities management solutions and integrated large scale access control systems.

\*<sup>1</sup> Compared to previous model (FVTC720).

\*<sup>2</sup> Users record patterns for two fingers. If the person is not identified by the first finger, authentication is repeated for the second finger. This significantly improves authentication performance.

### 2

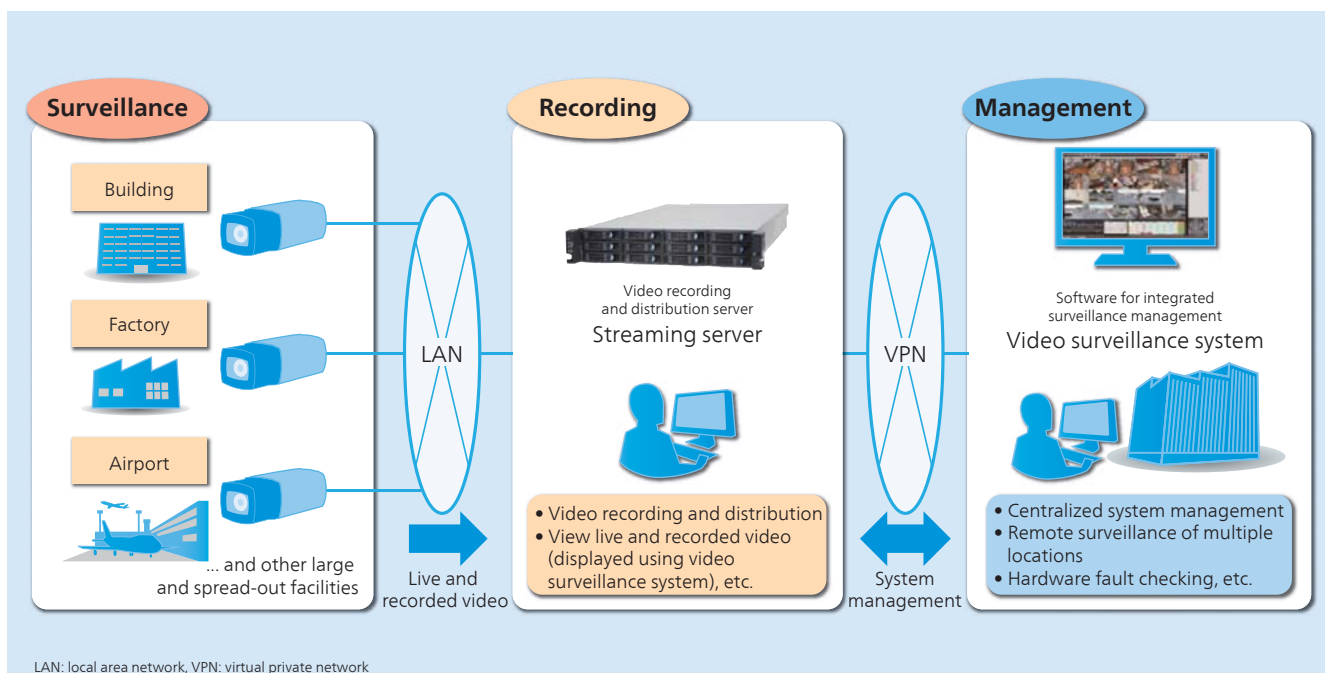
#### Video Surveillance Solution for Large Systems

Surveillance systems are growing in size and diversity in order to provide tighter security and more convenient video surveillance at companies, public facilities, and other sites, including increases in the number of cameras and centralized management from headquarters or a data center of camera images from multiple sites. Hitachi has introduced a new video surveillance solution for large systems that can seamlessly integrate its video surveillance system software for integrated surveillance system management of up to 32,000 cameras and 2,000 recording devices with its streaming server video recording and distribution servers, which can handle a large volume of video data (64 or more cameras) on a single server.

The main features are as follows.

- (1) It can connect network cameras\* from other vendors as well as Hitachi.
- (2) It provides high performance and high quality video recording and distribution that enable systems to be configured at low cost.
- (3) It provides efficient video management through a wide range of management functions and user interfaces.





## 2 Video surveillance solution for large systems

In the future, Hitachi intends to work on video solutions that combine collected video data with image analysis to provide video solutions that can be used not only to prevent crime, but also to help customers make operational improvements. (Hitachi Industry & Control Solutions, Ltd.)

\* Restrictions apply as to which models and settings can be used when connecting network cameras from other vendors.

## 3

### Large Three-phase Induction Motor

Recent years have seen greater use of high-capacity induction motors. In the oil and gas industry in particular, the demand is for robust induction motors that are compact and lightweight while still providing high capacity. These features make a major contribution to increasing flexibility and reducing the cost of transporting and installing new motors. Hitachi has recently developed a 13-MW class induction motor that is the highest rated model in its new development series that features modular and optimal design.

The new model expands the potential uses for induction motors, also providing the low starting current required by floating production, storage, and offloading (FPSO) systems.

## 4

### Security Gateway Intrusion Prevention System for Control Systems

The year by year increase in cyber-attacks on control systems is creating a need for security measures. Unfortunately, there has been a lack of progress on such measures because of difficulties associated with the use of existing security products, which have short product support periods and require specialist knowledge to specify the security settings. The issues include the fact that control systems do not allow configuration changes that impede reliable operation over the long term, and that the people who operate these systems do not have security expertise.

In response to this situation, Hitachi has developed an intrusion prevention system with the following features to prevent unauthorized access to control systems.

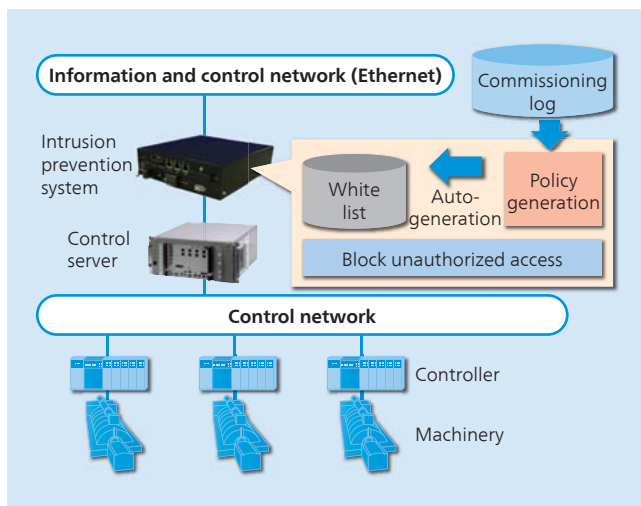
(1) Unauthorized data packets that do not satisfy predefined policies (a white list) are blocked, without the need to modify network settings for control system equipment when installing



Parameter	Specification
Voltage	13-kV class
Frequency	60 Hz
No. of poles	4
Output	13 MW

Note: A starting current of 300% is also available.

## 3 Photograph and specifications of the new 13-MW induction motor



4 Example use of intrusion prevention system

the intrusion prevention system.

(2) There is no need for specialist security expertise because the policies can be auto-generated based on the packet traffic that passes through the intrusion prevention system during commissioning.

In the future, Hitachi intends to expand use of the system beyond the nuclear power industry, where use of the system is already planned, to also include other industries and the public sector.

## 5

### Intelligent L2 Switch for Industrial Use

Developed by Hitachi, Intelligent L2 Switch is a small 10-port intelligent L2 switch for industrial use that combines long life (a 10-year design life) and advanced functions with excellent reliability and durability. In addition to more than 40 routine functions, including support for the simple network management protocol (SNMP) and spanning tree protocol (STP), the switch also uses a proprietary ring topology based on the core technology from the control network [International Electrotechnical Commission Publicly Available Specification (IEC PAS) 62953]. In configurations of up to 64 devices, functions for improving reliability include automatic recovery from network faults in less than 500 ms, route switching in response to intermittent as well as persistent faults, and duplication of blocking locations.

The switch also provides the following features thanks to a component mounting design and metal housing specially optimized by Hitachi.



5 Intelligent L2 Switch

(1) The switch can operate in ambient temperatures from  $-10^{\circ}\text{C}$  to  $60^{\circ}\text{C}$ .

(2) It is resistant to dust thanks to a housing that does not include a fan or ventilation slots.

(3) It has 4 G resistance to vibration [and also complies with class 1 of Japanese Industrial Standards (JIS) E3014].

These three features make the switch suitable for installation on machinery that is exposed to harsh environments.

Along with use in water, sewage, railways, and electric power systems, Hitachi also plans to expand its applications to include power generation systems in the future.

## 6

### New UX Series Industrial Inkjet Printer

Industrial inkjet printers are widely used in industries such as the food, beverage, cosmetics, and pharmaceuticals industries for the direct printing of date of manufacture, use by, lot number, and other quality management data. They are in high demand throughout the world, especially in countries where there is a strong awareness of quality such as Japan, Europe, and America.

Hitachi developed its new UX series of industrial inkjet printers based on the key concepts of reliability, simplicity, and environmentally conscious performance.

The main features are as follows.

(1) Ink and makeup fluids are supplied in cartridges produced by Hitachi that are simple to insert, minimizing problems such as users getting dirty hands. They also use near field communications (NFC) to prevent insertion of the wrong fluid.

(2) A proprietary system for minimizing solvent volatility reduces solvent use by approximately 50%\*.

(3) High-quality printing at high speed is achieved using new print control (reverse scan control, ink particle usage irregularity control).

(4) Easier operation using new screen designs with simple layout on a 10.4 inch (about 26.42 cm) thin-film transistor (TFT) liquid-crystal display (LCD).

(5) Easier connectivity to host system, with Ethernet provided as



6 New industrial inkjet printer designed for greater reliability, simplicity, and environmentally conscious performance

a standard feature (on the UX-E and UX-D).  
(Hitachi Industrial Equipment Systems Co., Ltd.)

\* When comparing the UX-E to the previous Hitachi model (based on Hitachi's measurements at 20°C using 1067K ink).

## 7 Variable-speed Oil-free Scroll Compressor with Inverter Control (3.7/5.5 kW)

Hitachi has developed a variable-speed oil-free scroll compressor with inverter control (3.7 and 5.5 kW) to improve the energy efficiency of these machines, which are characterized by being clean and quiet.

The main features are as follows.

- (1) Unwanted pressure rises are minimized by varying the electric motor speed in accordance with how much air is being used to maintain constant pressure. This reduces power consumption by approximately 10% compared to previous oil-free scroll compressors controlled by a pressure switch\*.
- (2) Can supply approximately 15% more air than conventional models\* using pressure quantity (PQ) wide mode, which can increase the amount of air being supplied in accordance with the operating pressure.
- (3) Due to lower load during compressor operation, the maintenance cycle has been lengthened\* from the four years (10,000 hours) of conventional models to five years (12,500 hours).
- (4) A single model covers two different pressures (0.8 MPa or 1.0 MPa) and can operate at different mains voltage frequencies (50 Hz or 60 Hz), each of which required separate conventional models.

(Hitachi Industrial Equipment Systems Co., Ltd.)

\* For a pressure setting of 0.65 MPa.



7 New V-type oil-free scroll compressor (5.5 kW-output)



8 New amorphous transformer series ultra-efficient transformer

## 8 Advances in New Amorphous Transformer Series

Growing demand is anticipated for the replacement of buildings constructed during Japan's economic bubble in the 1980s and, prompted by the recovery in capital investment, companies' aging electric power distribution equipment. In many cases, these replacements require transformers that are as small or smaller and as light or lighter than those they are replacing.

Hitachi has launched its new series of amorphous transformers to coincide with the April 2014 transition to level 2 standards of Japan's Top Runner Program\* in which achieving 115% or more of the standard is rated as ultra efficient. The latest enhancements are intended to improve suitability for the replacement market by making the transformers smaller (installation footprint reduced by up to 21%) and lighter (reduced by up to 11%), while still maintaining the same energy efficiency performance as the new series, which feature significantly lower losses. A three-phase 500-kVA transformer, for example, has the same installation footprint as a transformer from 30 years ago but 53% lower losses.

In addition to energy efficiency, Hitachi intends in the future to make new amorphous transformer series more compliant with societal requirements.

(Hitachi Industrial Equipment Systems Co., Ltd.)

\* Level 2 criteria for transformers designated as special equipment under the Act on the Rational Use of Energy.

## 9 New V-type Hoist

The performance of overhead and other cranes is maintained by performing periodic inspections and replacing parts that have reached the end of their lifetimes. As the electrical hoists widely used in overhead cranes need to be inspected and maintained, their maintenance requirements include being easier to inspect and having fewer and lighter spare parts. Hitachi has developed an electrical hoist that is easier to maintain thanks to features that include sharing parts wherever possible in the reduction gear,



9 New V-type hoist

which is rated for loads up to 3 t.

The main features are as follows.

- (1) Sharing of reduction gear parts between the 2-t and 3-t models reduces the number of spare parts from 56 to 36 (a 36% reduction).
- (2) The speed of the 3-t model has been increased from 0.125 m/s to 0.14 m/s (at 50 Hz) by increasing its motor output.
- (3) The operator can press emergency stop in the event of a

problem using the on/off button provided as a standard feature. (Hitachi Industrial Equipment Systems Co., Ltd.)

## 10 Use of Hitachi Positioning System for Materials Handling

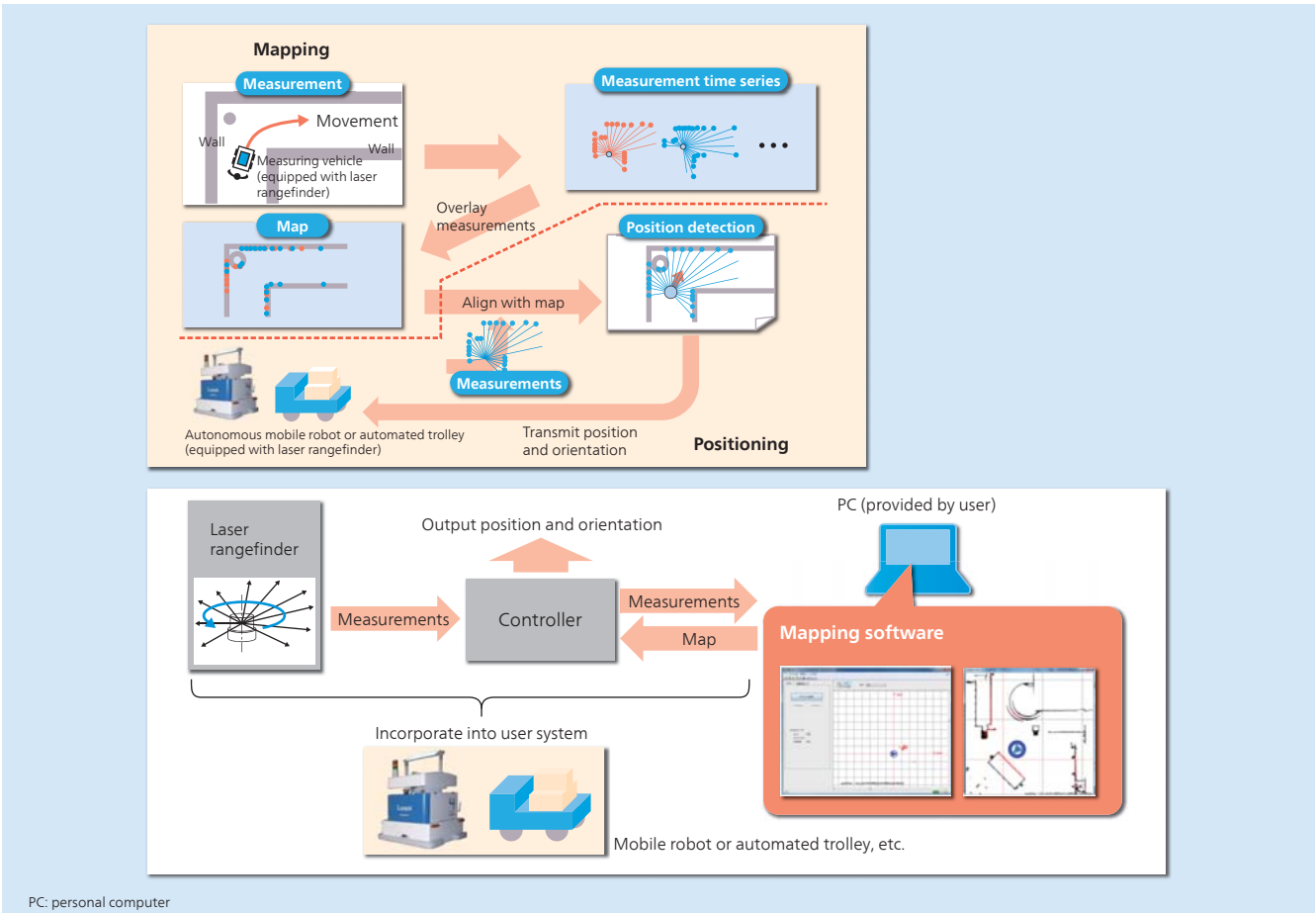
Services and other solutions that utilize positioning information have attracted attention in recent years. Recognizing this, Hitachi developed and commercialized Hitachi positioning system, which uses laser rangefinders to perform positioning.

Hitachi positioning system uses a proprietary algorithm to generate position information at 25-ms intervals with an accuracy of  $\pm 50$  mm and an orientation accuracy of  $\pm 3^\circ$ . Because Hitachi positioning system does not require any sensors other than its laser rangefinders, when used to control the movement of a vehicle, for example, it can provide reliable positioning regardless of the vehicle's design and characteristics.

Hitachi has also developed an automated materials handling system that includes autonomous mobile robots equipped with Hitachi positioning system. In recognition of this success, Hitachi positioning system won a FY2015 Technical Innovation Award from The Robotics Society of Japan.

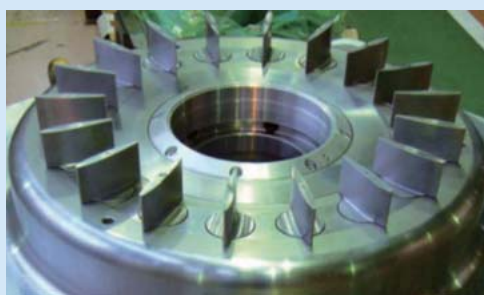
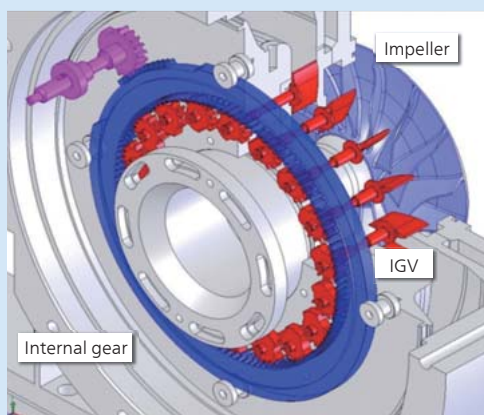
In the future, Hitachi aims to utilize Hitachi positioning system in the materials handling and service robot sectors (which are expected to grow), especially by incorporating functions that assist with specifying travel routes for use in the control of vehicles.

(Hitachi Industrial Equipment Systems Co., Ltd.)



10 How Hitachi positioning system performs mapping and positioning (top) and Hitachi positioning system block diagram (bottom)





11 Compressor with IGV for Rosneft (top) and IGV mechanism (center and bottom)

## 11 Completion of Centrifugal Compressors with IGV for Rosneft (Russian Government-owned Oil Company)

Hitachi has completed and delivered two compressors with inlet guide vanes (IGVs) ordered by Heurtey Petrochem for Rosneft, an oil company owned by the Government of Russia.

The main product features are as follows.

- (1) The compressors are for installation at a hydrogen production plant that uses steam methane reforming (SMR). The main component of the process gas is methane. The compressors have a required capacity of 2,600 kW and operate at  $10,879 \text{ min}^{-1}$ .
- (2) Although the two compressors have the same design and rated operating points, IGV angle control allows them to be routinely run at different operating points.
- (3) The compressors have a single shaft with 10 impeller stages and use a rotor stabilization technique to ensure highly reliable rotor dynamics.

The second and third of these features ensure that the compressors provide excellent cost-performance and have a wide operating range, combining IGVs with a single-shaft/10-impeller-stage configuration.

## 12

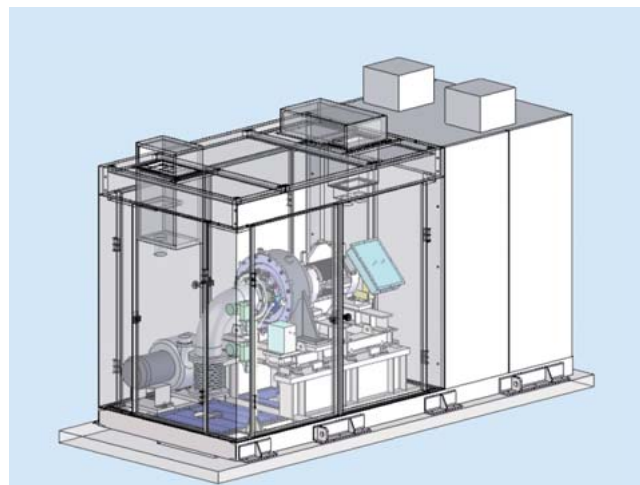
### First Installation of New High-speed, Single-stage Turbo-blower with Magnetic Bearings

In an example of a next-generation product that contributes to society by being environmentally clean and energy efficient, Hitachi has added a new high-speed, single-stage turbo-blower with magnetic bearings to its existing range.

Three units ordered for the final treatment plant of Iizuka City Water and Sewer Bureau in Fukuoka Prefecture in 2013 commenced operation in December 2014.

The main features are as follows.

- (1) Mechanical contact is eliminated by using bearings that work on the principle of magnetic levitation, whereby the rotor is supported by magnetic force.
- (2) Use of the latest three-dimensional impeller allows the turbo-blower to be small and highly efficient with a wide operating range.
- (3) Use of a floating shaft improves energy efficiency by minimizing mechanical losses.
- (4) The oil-free design is environmentally clean and eliminates the need for a lubrication system.
- (5) The integrated design combines the blower unit and electrical control unit (control panel), with a touch panel for operation and monitoring.



12 Design and photograph of high-speed, single-stage turbo-blowers with magnetic bearings

### 13 Energy-saving Solution Using Oil-free Screw Compressor with Waste Heat Recovery Heat Exchanger

Recent years have seen growing interest in reducing carbon dioxide (CO<sub>2</sub>) emissions and saving energy, with various proposals and developments relating to the air compressors that are used as a power source at factories. Hitachi has recently devised a waste heat recovery solution and undertaken the system design to build an oil-free screw compressor with a waste heat recovery heat exchanger.

The waste heat recovery technique used on the compressor involves using a heat exchanger to recover the heat generated when compressing air so that it can be used for purposes such as preheating the water supplied to a boiler or as a heat source for air conditioning (water at 35°C or higher can be used for hot water recovery at 45 to 80°C, for example).

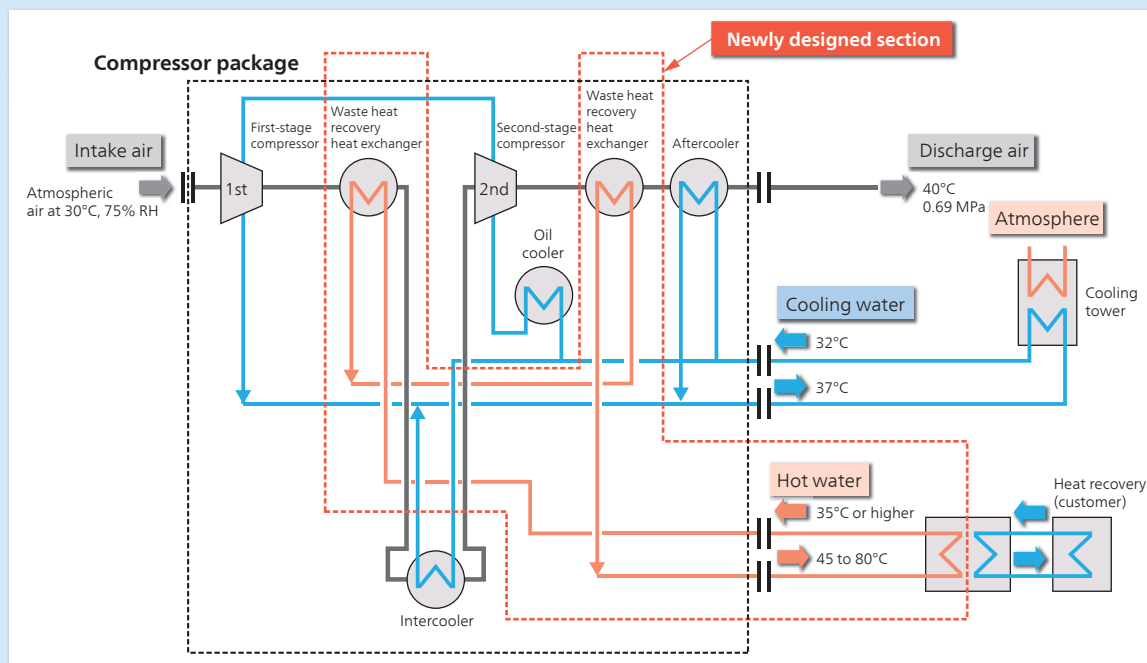
The main features are as follows.

- (1) The proposed energy efficiency solution comprises a complete system (450-kW and 400-kW units in this case).
- (2) An oil-free screw compressor was developed that incorporates two heat exchangers for better waste heat recovery.
- (3) It has the same dimensions as the existing model (SDS-U series oil-free screw compressor).

In anticipation of rising demand for reducing CO<sub>2</sub> emissions and saving energy, Hitachi intends to expand its product range and offer refurbishment of existing units.

### 14 One-stop Maintenance Enhancement Service for Drastically Reducing Risk of Equipment Outages

In recent years, factors such as difficulties in staff recruitment due to the falling working population and improvements to service



RH: relative humidity

13 Flow diagram when using the waste heat recovery heat exchanger and photograph of SDS-U series oil-free screw compressor

quality, including offering same-day delivery, mean that outages on materials handling equipment used to automate delivery services can have a major impact on customer operations. Recognizing this situation, Hitachi operates a one-stop maintenance service incorporating the following maintenance enhancement services with the aim of drastically reducing the risk of equipment outages.

(1) Engineering service for maintenance planning based on risk assessment

Based on a risk assessment for each equipment component, this service formulates long-term maintenance plans and periodic inspection plans that take account of cost optimization.

(2) One-stop enhancement service that coordinates maintenance with equipment vendors

This service achieves faster problem recovery by working with materials handling equipment vendors, not only on Hitachi products, but also on responding to problems across the entire materials handling system.

(3) Prompt onsite arrival service that draws on Hitachi's extensive network of operations

Shorter onsite arrival times are achieved through 24 hours a day, 7 days a week maintenance service network operated from approximately 300 sites around Japan.

In addition to these services helping customers maintain more reliable equipment operation, Hitachi also intends to enhance maintenance services further using advanced information technology (IT) such as big data analytics.

of production practices) from research and development to the departments responsible for actual production is one of the challenges to speeding up the bringing to market of new technology and new product developments. At pharmaceutical companies, for example, two stages of technology transfer are required, one for the transition from research and development to production for clinical trials, and another to commercial production. Speeding up this process is a source of competitive advantage. The underlying cause of the challenges of technology transfer lies in the coordination required between the provider and recipient of the technology, with the former holding information about production practices and the latter being subject to equipment-based constraints. In response, Hitachi provides solutions and services to standardize ways of expressing production practices developed by the research and development department by breaking them down into procedures and parameters and then organizing them as more structured production practices. It is also able to shorten the time for technology transfer using the same platform for sharing and investigation by organizing the constraints associated with the equipment used by the manufacturing department in a similar manner.

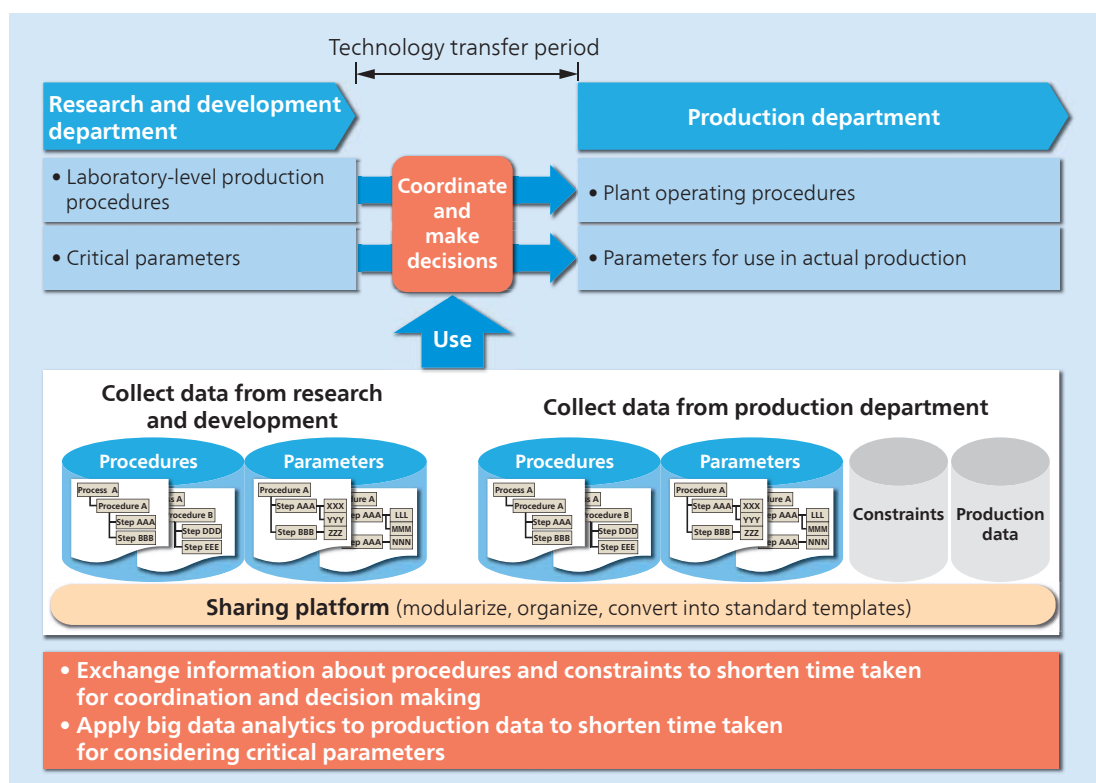
Furthermore, by applying big data analytics to collected production data to determine critical parameters, Hitachi further reduces the time taken for technology transfer by making faster decisions about the choice of parameters.

The actual implementation involves incorporating this function into a manufacturing execution system (MES) that is one of the most widely used in the pharmaceutical industry in Japan. Starting in the pharmaceutical industry, Hitachi intends to contribute to the progress of manufacturing around the world by extending its use to other manufacturers who need to perform similar technology transfers.

## 15

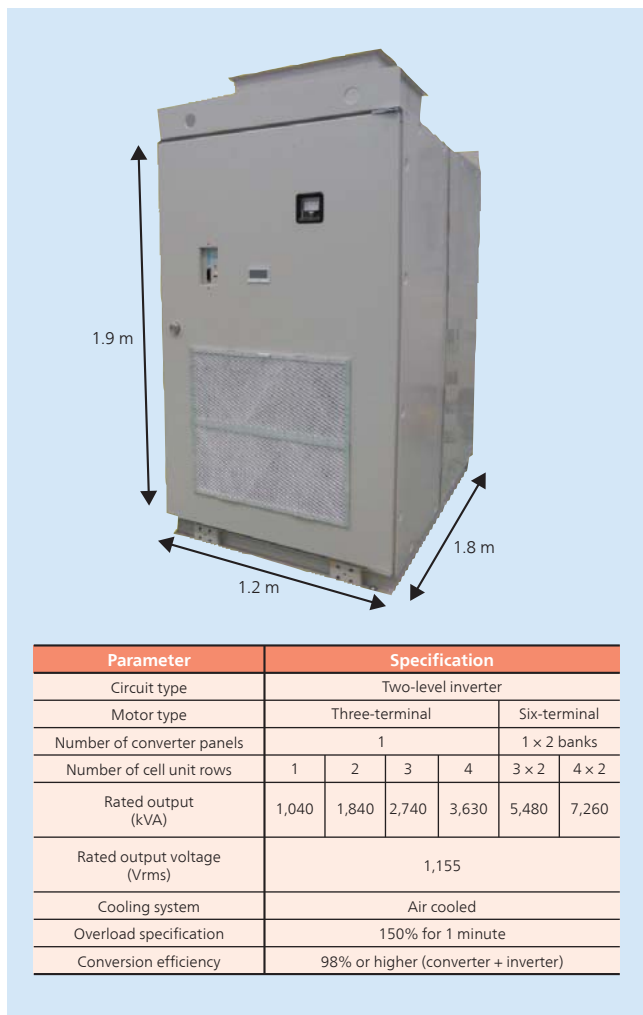
### Solutions and Services for Faster Market Entry by Manufacturers

In process manufacturing, technology transfer (the handing over



15 Solution for achieving faster market entry

# Plant and Factory Equipment



1 Photograph and specifications of medium-capacity IGBT inverter (third generation)

## 1

### Medium-capacity IGBT Inverter (Third Generation)

Hitachi has been involved in new installations and replacement projects for medium-capacity insulated-gate bipolar transistor (IGBT) inverter drives in Japan and elsewhere for roughly 20 years since releasing its first generation in 1996, with the second generation following in 2003. Hitachi has now gone on to develop a third generation with a new design intended to satisfy more global user requirements. The new generation has been fully revised, including different device dimensions and range of capacities.

The main product features are as follows.

(1) 3.3-kV/1.5-kA (3.0-kAp) IGBT devices (global standard) are used to ensure long-term product availability and larger output capacity\*.

(2) Smaller size achieved by simplifying the circuit design (the panel width dimension is 60% narrower than the equivalent previous 2,750-kVA model).

(3) To provide the best drive system to suit user needs, a series of different capacities are available by connecting the drive circuits in parallel.

(Commencement of production: October 2015)

\* Maximum capacity is 3,630 kVA (or 7,260 kVA in a two-bank configuration).

## 2

### Commissioning of Cold Rolling Mill Using New Controller

Hitachi has been commissioning a number of plants that use its new controller, including both new and retrofit projects.

In South Korea, a continuous pickling line and tandem cold mill (PL-TCM) supplied to Hyundai Steel Company commenced production in May 2015 and has been operating reliably. This was the first plant where Hitachi replaced existing controllers with the new model. The electrical equipment upgrade provides higher reliability and improves maintenance, including through the introduction of sophisticated analytical tools.

The new controller features a more efficient implementation, faster processing, and higher reliability. Thanks to the experience and know-how that Hitachi has built up in the replacement of electrical equipment, commissioning of the upgrade was completed in just one month.

Hitachi expects to install more of the controllers in the future in response to rising demand from both new and retrofit projects. To achieve this, Hitachi aims to make progress on further standardizing on-site commissioning to achieve a faster plant startup and supply more valuable systems.



2 Cold rolling mill at Hyundai Steel Company in South Korea





3 Delivery-side operator's desk at No. 2 CAL of CSC in Taiwan

### 3 Projects to Replace Electrical Equipment from Other Vendors at Processing Lines Outside of Japan, and Commencement of Commercial Operation

Hitachi received an order to replace electrical equipment from other vendors at the No. 2 continuous annealing line (CAL) at China Steel Corporation (CSC) in Taiwan and the No. 2 continuous galvanizing line (CGL) at Tata Steel Limited in India. The on-site work and commissioning were completed on schedule and the plants are operating reliably.

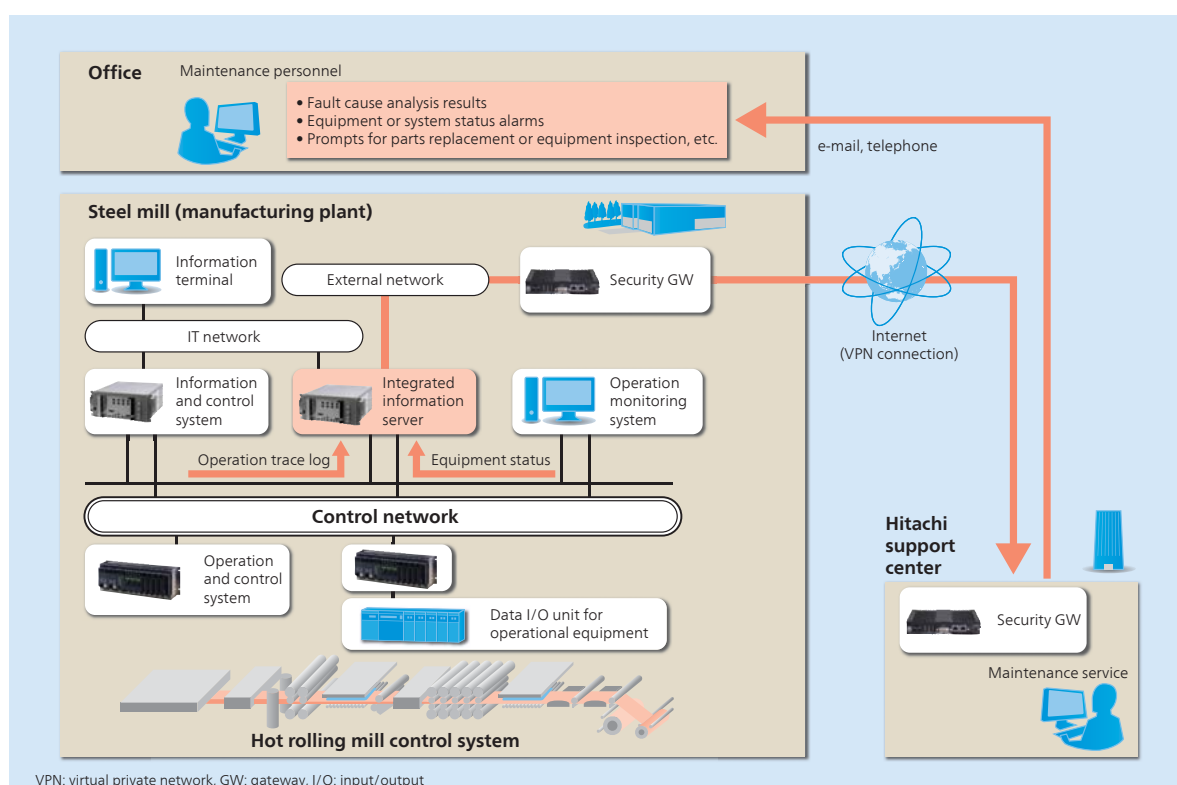
The CSC project involved replacing the line motors, line drives, programmable logic controllers (PLCs), process input/output (PIO), and writing new software to work with the existing equipment. Thanks to Hitachi's extensive technologies and project management capabilities, the on-site work and commissioning were completed within the schedule proposed by the beneficial existing equipment supplier. This was a major result in the context of future growth in orders for the replacement of electrical

equipment from other vendors. The project also included the use of line drives from Hitachi Hi-Rel Power Electronics Pvt. Ltd. in India, thereby providing an opportunity to establish a reference site at a large plant outside of India. The Tata Steel order was a locally supplied project handled by Hitachi India Pvt. Ltd., with design, manufacturing, and a short on-site commissioning being undertaken by local staff with technical guidance from Hitachi. The plant commenced operation without any major problems, making it an auspicious start to the expansion of business in India.

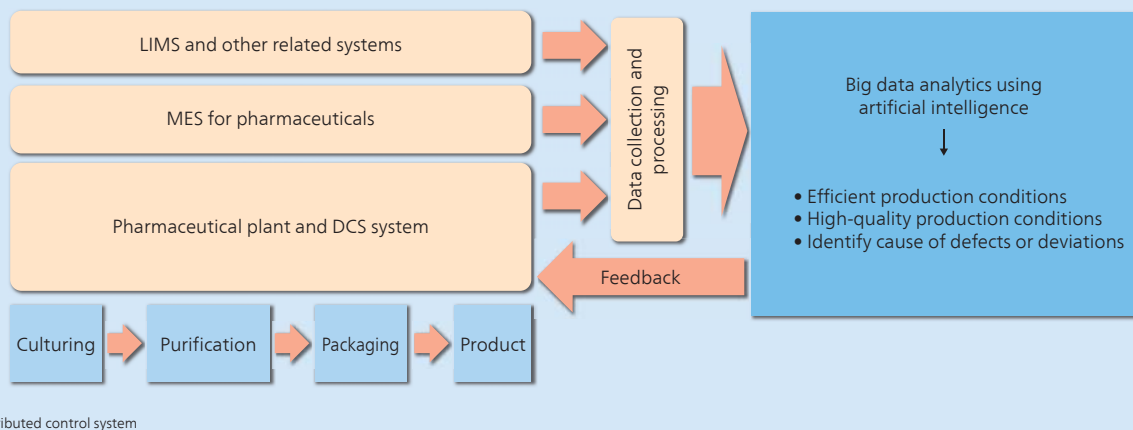
In the future, Hitachi intends to work toward increasing orders for processing lines by strengthening collaboration with subsidiaries in India and China so that it can have an active involvement in similar projects.

### 4 Integrated Information Platform for Advanced Maintenance Services at Steel Hot Rolling Mill in India

Advances in steel industry control systems mean that maintenance staff require ever-higher levels of knowledge and skills year-on-year, with suppliers being expected to provide more advanced maintenance support to ensure reliable system operation. Hitachi has developed an integrated information platform that is intended to provide rapid identification and resolution of fault causes and better preventive maintenance for a system supplied to a steel hot rolling mill in India. The platform enables centralized management of the status of system equipment (whether or not equipment is operating or has a fault), operation trace logs [including for the central processing unit (CPU) and communications], alarms, event logging, and other information. This can reduce downtime by utilizing multiple data sources to perform cause analysis before equipment faults occur, and warn of situations with the potential to result in system faults. It also supports remote maintenance to



4 System block diagram of remote maintenance support service



## 5 Overview of big data analytics solution

provide high-quality maintenance support to customers or global plants with limited maintenance personnel.

In the future, Hitachi intends to expand the scope of information managed by the integrated information platform to include things like sensor and control data, and to link it to external analysis systems to provide advanced maintenance services that use big data (such as predictive diagnostics or advanced analytics).

## 5 Big Data Analytics Solution for Pharmaceutical Plants

Hitachi has contributed to improving production efficiency and introducing stricter manufacturing and quality management processes for pharmaceutical companies by promoting the use of information technology (IT) such as plant automation, manufacturing execution systems (MES), and laboratory information management systems (LIMS).

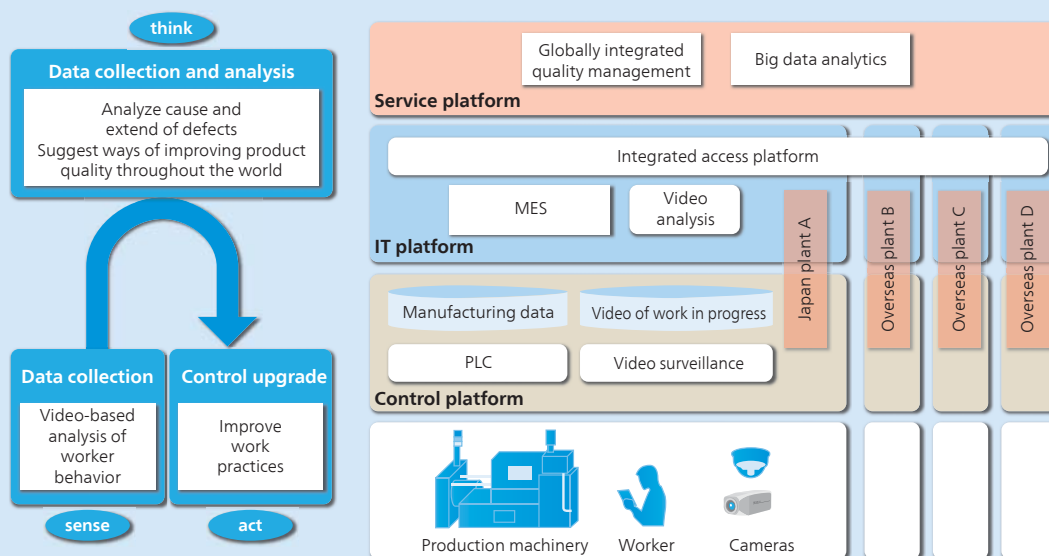
In recent years, based on new technology factors such as big data analytics, the demand for using information collected by these IT systems is increasing. Hitachi is seeking to achieve high

quality and highly reliable manufacturing through the analysis of data from both equipment on the pharmaceutical shop floor and from MES/LIMS, to identify new correlations between process data and data such as volume and quality of finished goods especially for the growing biopharmaceutical industry.

The strength of Hitachi is that it can deliver total solutions ranging from plant design and plant construction, to computer systems such as LIMS and the Hitachi pharmaceutical manufacturing execution system, which has the top market share in Japan. Based on current solutions that collect and process manufacturing data, Hitachi is striving to provide new solutions that combine existing data with big data analytics using Hitachi artificial intelligence technology.

## 6 Next-generation Global Manufacturing Management Using Sensing Technology and Practical Know-how

Hitachi has utilized its sensing technology and practical manufacturing know-how to develop a next-generation manufacturing management system. It is possible to use images to track manufac-



## 6 Improvements to product quality throughout the world using next-generation manufacturing management system

turing performance in terms of people, machines, and material by installing cameras of various different types (fixed, omnidirectional, distance image, and so on) at an assembly plant and collecting images of the plant and linking them to an MES that contains accumulated practical know-how. This prevents large-scale recalls by facilitating analysis of the extent of the problem when a defect occurs.

Hitachi is currently working to implement functions that use realtime analysis of images to prevent defects from proceeding to downstream processes by detecting changes that influence quality before starting the next cycle, such as the behavior of workers who deviate from standard practices (people), supervision by supervisors (people), abnormal operation by equipment (machines), and component supply (material).

Hitachi is also making improvements to product quality globally by integrating information (processing data, work video, and so on) from plants located around the world and using big data analytics to analyze the causes when a defect occurs or to suggest improvements and provide feedback to the plant.

## 7

### Completion of All-weather Environmental Test Facility for Obayashi Corporation

Hitachi Plant Mechanics, Co., Ltd. completed an all-weather environmental test facility for Technical Research Institute, Obayashi Corporation in June 2014. This facility is composed of twin high/low temperature test rooms.



7 Test room when the solar simulator lights are on (top) and test room after continuous operation of the snow simulator (bottom)

These test rooms are able to simulate all kinds of global climate conditions aimed at conducting several seasoning tests for environmental materials, to be combined with several environmental parameters such as temperature, relative humidity, rainfall, snowfall, wind force, and sun-light intensity, respectively.

These twin rooms are compatible for concurrent testing of architectural materials under indoor and outdoor conditions simultaneously, by removing internal wall in between the test rooms, and setting different climate conditions for each room independently.

(Hitachi Plant Mechanics Co., Ltd.)

## 8

### Factory-assembled Contaminated-wastewater Storage Tanks

The first shipment of contaminated-wastewater storage tanks for Fukushima Daiichi Nuclear Power Station started on November 24, 2014, which had been ordered by Tokyo Electric Power Co., Inc. via Hitachi-GE Nuclear Energy, Ltd.

These tanks are categorized as middle- and low-level contaminated water storage tanks among the purification facilities at the Fukushima site. These tanks are known as some of the biggest factory-assembled tanks, and are cylindrical in shape (approximately 12.5 m in height, 12 m in diameter), with a capacity of approximately 1,220 m<sup>3</sup>, dry weight of approximately 90 t, and are made of SM400C carbon steel similar to ASTM A283. The inside and outside surfaces are painted. Hitachi Plant Mechanics, Co., Ltd. and its cooperating manufacturers have produced the tanks within a short delivery time using their advanced welding and fabricating techniques, covering the required earthquake and pressure resistance. Fabrication has been ongoing since August 2015 for the next delivery, and marine and land shipments are being processed for subsequent installation at the Fukushima site. (Hitachi Plant Mechanics Co., Ltd.)



8 Tanks that were shipped in November 2014