

# Industrial Infrastructure

Substation Systems  
Industrial Plants  
Industrial and Instrumentation Equipment



## Outlook

### Substation Systems

Our substation system business makes use of electric distribution facilities and large-capacity power electronics equipment for sectors including the electrical power, industrial and transportation sectors while we also continue to develop business solutions for increasing reliability and efficiency, as well as measures for the environment. In Asia, we established Fuji Tusco Co., Ltd. and Fuji Electric Manufacturing (Thailand) Co., Ltd. in Thailand as production bases for power transformers and switching devices, in order to satisfy the expectations for infrastructure expansion. To deploy a locally self-sufficient business having sales, engineering and production bases, we also focus on the enhancement of engineering bases and promote system construction.

For the electrical power sector, we delivered 300-kV gas insulated switchgear (GIS) to a thermal power plant in Japan to support stable and reliable power supply.

As an achievement related to electrical equipment in the industrial sector, we upgraded existing equipment to ensure stable operation. We are actively developing solutions to improve reliability by means of maintenance services such as equipment diagnostics of aging equipment. We are also actively suggesting equipment developed while considering the environment, energy conservation and low maintenance. As for achievements related to power supply for industrial use, with growing requests for an improvement in power quality, we delivered a large-capacity self-commutated flicker compensator to a Japanese electric furnace manufacturer in order to suppress fluctuations in the power system voltage.

For the transportation sector, we upgraded the facility of an existing substation to ensure stable transportation and delivered power supply equipment and power management/power monitoring systems for a new subway line.

### Industrial Plants

In Japan, companies have continued making solid

investments from the previous fiscal year in the upgrading of aging equipment and in rationalization for strengthening competitiveness, mainly in the material industry. In addition, many companies in some sectors of the assembly and processing industry are planning to enhance facilities as part of reviewing supply chains (return to domestic production). In overseas markets, it is true that some companies are starting to rethink equipment investment due to the excessive supply and lower resource prices that have resulted from the economic slowdown in the Chinese market. Basically, however, equipment investment is tending to expand in Asia and some other regions.

Our industrial plant business has been deploying products and systems that achieve stable operation of production equipment and effective use of energies. They center on drive control, measurement control, machinery and electric, environmental and information technologies.

For the metal industry, we have developed new industrial drive control equipment that helps to enhance and informatize drive systems, and started mounting it on products on a timely basis. In order to enhance engineering efficiency and quality, we have developed a converter and various control system packages to run the existing software on the latest system and are promoting their introduction.

For the chemical and food industry, the investments in end product manufacturing equipment are increasing due to the diversified needs of end consumer products. By combining the distributed control system "MICREX-NX" or "MICREX-VieW XX" with a PC, we offer solutions that satisfy customer requests such as batch control, recipe management and a traceability function.

For the waste disposal industry, we see an increase in the installation of new equipment because customers are carrying out business integration and upgrading their existing control systems. For the upgrade work, we utilize customers' software and other existing resources as much as possible. For the installation of new equipment, we take advantage of new functions of

the latest system to optimize customers' equipment operations and life cycle costs.

For the distribution system industry, we have developed and released an energy saving system for refrigerated warehouses where freezer operation is optimized based on our original algorithm. This system can reduce annual amount power consumption by 12% or more.

For data centers, the construction of them has been expanding in recent years, and this presents the challenge of reducing air-conditioning power consumption for cooling servers that are designed for higher performance and density. As a solution, we have developed an ultra-high efficiency data center for cold regions by adopting an indirect outside air conditioning unit "F-COOL NEO," and delivered it. The idea is to collect snow and ice in winter, store them in a heat-insulated container and use the heat of fusion from their melting as a coolant in the summertime. This can reduce annual air-conditioning power consumption by 60% compared with the case where a general-purpose air-conditioner is used.

An international convention (MARPOL) requires the reduction of CO<sub>2</sub> and environmentally impacting substances (NO<sub>x</sub>, SO<sub>x</sub> and PM). We have developed an exhaust gas cleaning system for ships (cyclonic SO<sub>x</sub> scrubber) in conformance with SO<sub>x</sub>/PM regulations and put it through the test for the joint research of Nippon Kaiji Kyokai and Imabari Shipbuilding Co. (Target: New ship owner institution). Our aim is to help conserve the marine environment and reduce business costs, which is a challenge in the marine industry.

### Industrial and Instrumentation Equipment

Our industrial and instrumentation equipment business is offering a range of products including instrumentation equipment and sensors, radiation equip-

ment and systems, and industrial electric heating to meet the requirements of customer environmental policies, energy-saving, and safety and security standards. We are also working to create a sensor platform and a network sensor for the IoT age.

In the sector of instrumentation equipment and sensors, we are developing feature-rich products for the environment and energy-saving field. As for liquid flow measurement, we have developed and released a spool type ultrasonic flowmeter called "FST," which provides accuracy equivalent to Coriolis flowmeters. We will add specifications according to applications such as a greater variety of diameters, explosion proof certification, and communication functionality. We will also promote the development of a gas and vapor flowmeter for energy-saving applications based on ultrasonic measurement technology as well as of application products designed for specific uses.

In the sector of radiation equipment and systems, we have been developing a new personal dosimeter intended for overseas markets and promoting the development of process monitor technologies. We will complete the production of a whole line of dosimeters for overseas markets and the product development of process monitors, and introduce them into markets. Moreover, we will promote the development of service business centered on environmental dose control and of monitoring technology related to reactor decommissioning.

In the sector of industrial electric heating, we have established a new line of high-efficiency and compact melting furnaces. We will accelerate the expansion into domestic and overseas markets. We will also add products to the line of small IH inverters of 5 kW or less mainly intended for kitchen applications and promote the expansion including new applications.

## Substation Systems

### 1 Replacement of Electrical Equipment in Edogawa Extra-High-Voltage Power Receiving Substation for Shinjuku Line of Bureau of Transportation of Tokyo Metropolitan Government

The Edogawa Extra-high-voltage Power Receiving Substation receives 66 kV from Tokyo Electric Power Company, Incorporated in 2 lines and transmits the power to a 22-kV DC feeding substation and 6.6-kV station electrical room in 3 lines respectively. Fuji Electric delivered such equipment as 72-kV/24-kV switchgear, extra-high-voltage transformer for 15-MVA reception/4.45-MVA rectifier/5-MVA high-voltage distribution, a pure water vaporization-cooling silicon rectifier and a 1,500-V DC/7.2-kV AC enclosed switchgear.

- (1) The 72-kV/24-kV switchgear has been made compact size by adopting a gas-insulated C-GIS.
- (2) The extra-high-voltage transformer adopted SF<sub>6</sub> gas insulation, offering excellent safety and disaster prevention.
- (3) It is possible to have mutual power interchange with the power transmission systems of adjacent substations at 22 kV AC/6.6 kV AC/1,500 V DC to ensure safe and stable train transportation.

Fig.1 24-kV AC C-GIS and 1,500-V DC/7.2-kV AC enclosed switchgear



## Substation Systems

### 2 Direct Current Electric Power Converter in Maya Station of West Japan Railway Company

Fuji Electric delivered direct current electric power converter to West Japan Railway Company. This equipment converts 1,500 V DC into single-phase 200 V to achieve energy saving by using regeneration power that is generated when a train brake is applied as a power supply for lighting in the station and other purposes. This is the first introduction to West Japan Railway Company. This equipment consists of a DC high-speed circuit breaker, an inverter, a protection device, a simplified remote monitoring and control device and a storage battery control panel. The main features are as follows:

- (1) The equipment has an enclosed switchgear structure intended for outdoors, and it provides excellent maintainability.
- (2) Based on our know-how in regeneration power absorbing equipment accumulated over many years, the equipment is controlled without any influence on signal and communication systems.
- (3) A reverse-power-flow protection function is provided.

Fig.2 Direct current electric power converter



### 3 300-kV GIS for Shin-Sendai Thermal Power Station No. 3 Series of Tohoku Electric Power Co., Inc.

Fuji Electric delivered 300-kV gas insulated switchgear (GIS) as extra-high-voltage electric equipment for Shin-Sendai Thermal Power Station No. 3 Series of Tohoku Electric Power Co., Inc.

As countermeasures against tsunami, the GIS is installed on a large steel platform. For this layout, we conducted in advance strength analysis including the GIS and confirmed that sufficient strength and safety could be ensured. Fuji Electric's 300-kV GIS is a lightweight model that employs aluminum enclosures and this feature is effectively applied to the seismic design.

No. 3-1 of the Shin Sendai Thermal Power Station started commercial operation in December 2015 and No. 3-2 is scheduled to start commercial operation in July 2016.

Fig.3 Shin-Sendai Thermal Power Station 300-kV GIS



### 4 Large-Capacity Self-Commutated Flicker Compensator for Steelmaking for Sanko Seiko Co., Ltd.

In December 2015, we delivered a large-capacity self-commutated flicker compensator for steelmaking to Sanko Seiko Co., Ltd. through JP Steel Plantech Co. Rapid fluctuation of the system voltage due to operation of an electric furnace may cause flicker disturbance. This equipment, which is intended for suppressing fluctuation of the system voltage, is composed of a 40-MVA unit including a 2-multiple transformer and inverter and 35-MVar capacitor equipment. The main features are as follows:

- (1) Replacing the existing large-capacity line-commutated flicker compensator (line commutation capacity 90 MVA, filter capacity 78.5 MVar), the self-commutated flicker compensator achieved a high flicker-compensation performance with small equipment capacity.
- (2) Employing a water-cooled 3-level inverter with a low-profile compact vertical shape enabled the equipment to be installed in the existing electric room with size limitations.

Fig.4 Large-capacity self-commutated flicker compensator for steelmaking



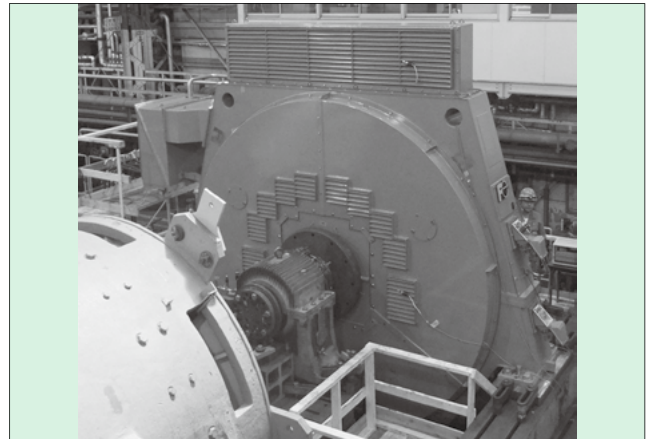
## Industrial Plants

### 1 Synchronous Motor for Reciprocating Compressors for Sumitomo Chemical Company, Limited

Fuji Electric has replaced synchronous motor for reciprocating compressors for Sumitomo Chemical Company, Limited. The replacement motors are 3-kV, 3,040-kW, 26-pole synchronous and 3-kV, 600-kW, 14-pole induction motors. The main features of synchronous motor are as follows:

- (1) Compactness has been achieved by adopting a structure with the motor rotor overhanging the compressor shaft to eliminate the bearings on the motor own.
- (2) The starting current has been successfully reduced by using a part winding structure.
- (3) A separate main terminal box eliminates the need for cable termination work when the stator is moved, improving maintainability.

Fig.5 3-kV, 3,040-kW, 26-pole synchronous motor (factory test)



### 2 CE Mark-Conforming "FRENIC-VGM" Inverter Panel

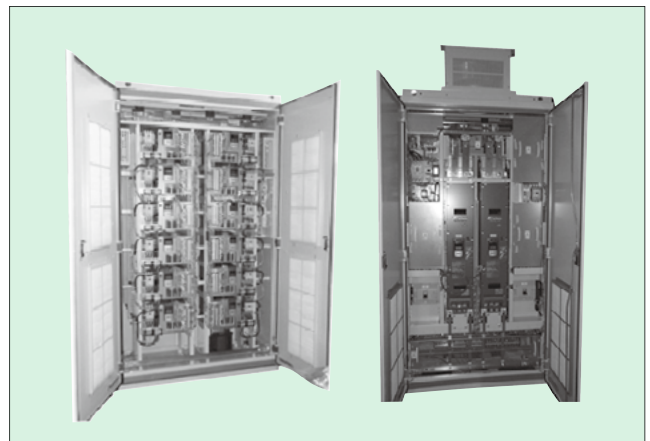
For cold-rolled steel strip processing lines outside Japan, we manufactured and delivered the "FRENIC-VGM" inverter panel that meets CE Marking.

CE Marking requires compliance with the EN Standards and IEC standards but the concept of grounding systems is significantly different from that of Japanese standards. In addition, it is necessary to use the structure of a panel and in-panel devices in accordance with CE Marking requirements, and we significantly revised the conventional basic specifications.

For this inverter panel, Fuji Electric carried out a conformity assessment based on the EC Directives and declared it to be in conformity with CE Marking.

We are contributing to the expansion of the electric power-applied plant business outside Japan by enhancing the product line-up with inverter panels conforming to EN standards and IEC standards

Fig.6 "FRENIC-VGM" inverter panel

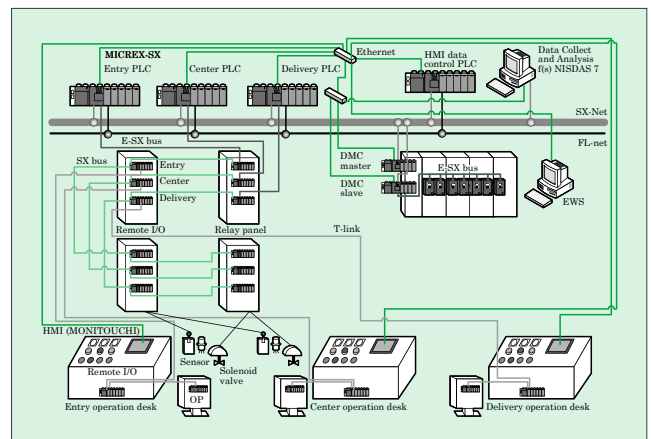


### 3 Continuous Galvanizing Line Electric Equipment

We delivered continuous galvanizing line electric equipment for a certain company in Indonesia. This equipment is composed of the latest control system to achieve high performance and reliability, and is provided with improved additional functions such as maintainability and operation visualization. The main features are as follows:

- (1) "FRENIC-VGM" has been employed as the drive and "SPH3000MG" as the controller that controls the various sections and controls drives (DMC) to build a network with the gigabit control LAN "SX-Net."
- (2) One unit of DMC is capable of controlling up to 64 drives and the maintenance tool can be used via the Ethernet to conduct overall monitoring of the DMC.
- (3) "f(s) NISDAS 7" on the SX-Net can be used for high-speed collection of plant data for thousands of points (1,024 words/1 ms).

Fig.7 System configuration

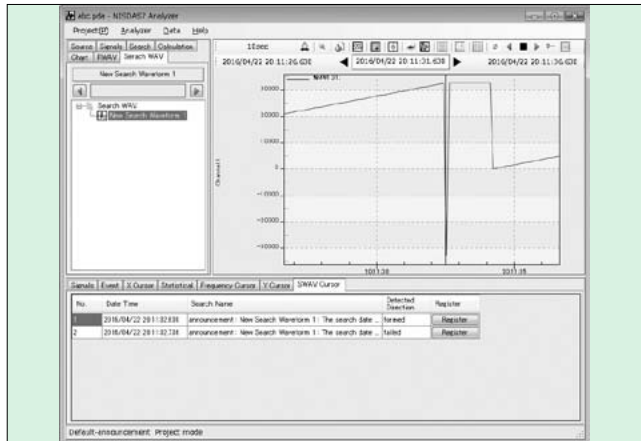


## Industrial Plants

### 4 New Functions of Data Collection and Analysis Support Package Software “f(s) NISDAS 7”

Fuji Electric offers “f(s) NISDAS 7,” data collection and analysis support package software for stable operation and preventive maintenance of equipment. A function of collecting common memory values of FL-net (OPCN-2) has now been added. FL-net is a controller level network that achieves communication between controllers, such as PLCs, robot controllers (RCs) and computer numerical control (CNC) units, and PCs. Signals can be registered simply by registering the variable name of each communication node. The variable names correspond to the notations of “SX-Programmer Expert” and “SX-Programmer Standard” of the “MICREX-SX Series.” In addition, a waveform search function has been added to the analysis function. This makes it easy to search for specific events on the equipment and contributes to stable operation.

Fig.8 Waveform detection result screen

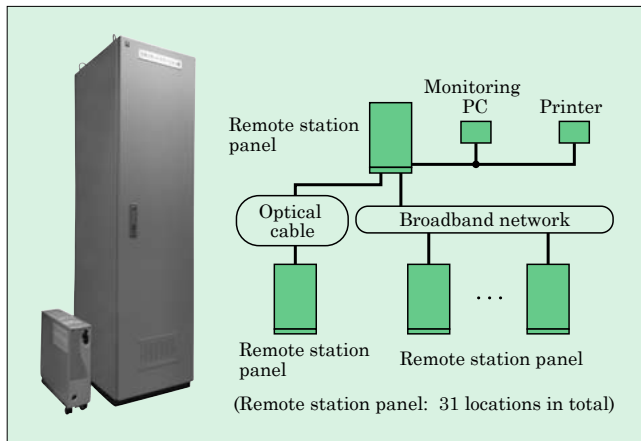


### 5 Elevating Machine Monitoring System for Terminal 1 of Narita International Airport

Fuji Electric delivered an elevating machine monitoring system for Terminal 2 of Narita International Airport, and it has earned customer’s trust with many years of stable operation. We have won an order for work to replace the elevating machine monitoring system for Terminal 1 of the airport and completed the work without any problem by closely examining in advance the existing system provided by another company.

The system collects status signals of 79 elevators, 88 escalators and 33 moving walkways around the terminal building with the remote station panels newly installed in the vicinity (in 31 locations) to provide centralized monitoring with a monitoring PC installed at the center via LAN. The communication system used for the elevating machines was the manufacturer’s proprietary one, and we have dealt with this by devising the interface. This system employs “FOCUS-SX.”

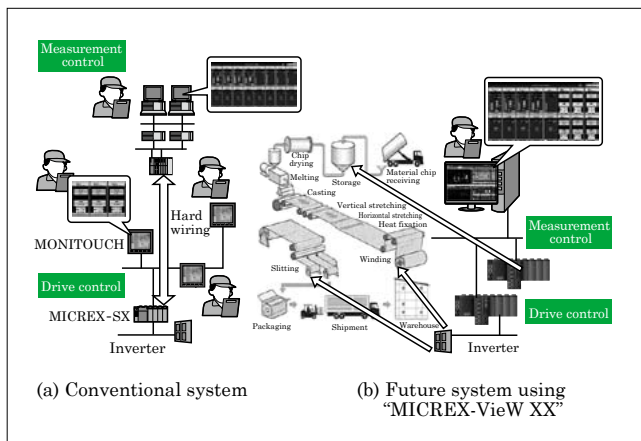
Fig.9 Remote station panel and system configuration



### 6 Monitoring and Control System Package for Chemical Plants

One feature of Fuji Electric’s monitoring and control system is EIC integration. To roll out the product into the chemical industry and further into the pharmaceutical industry and the food/beverage industry, we have developed the functions required for the respective fields from the perspective of integration of drive control and measurement control on “MICREX-VieW XX,” the common platform. The functions are integrated management of the electric equipment faceplate and measuring instrument faceplate as an integrated solution, batch control package conforming to international standard S88 and electronic recording and electronic authentication package compatible with international standard Part 11. Based on these 3 functions, we offer to the market a compact system that seamlessly integrates drive control with measurement control. In addition, we have reduced the management cost by having integrated management of drive and measurement data and unitary management of equipment.

Fig.10 Integration of drive control and measurement control



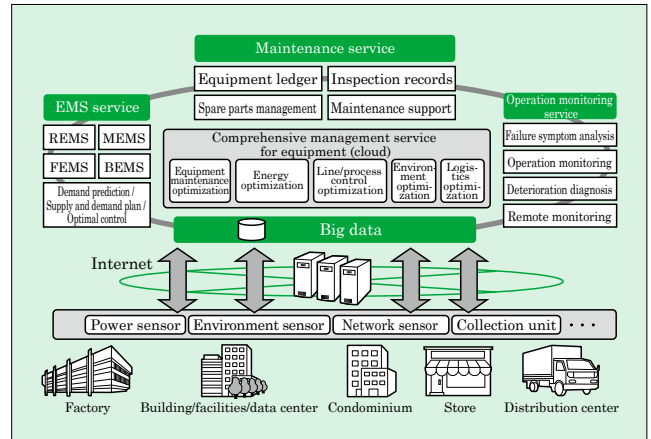
Industrial Plants

7 Functionality Enhancement for Comprehensive Equipment Management Service

Fuji Electric has developed a cloud-based comprehensive equipment management system that realizes an equipment life cycle management environment and started providing the service.

In FY2015, to the “EMS service” already provided, we newly added “operation monitoring service” and “maintenance service” functions for equipment to realize an integrated cloud-based service. Utilization of this cloud-based service has made it possible to predictively diagnose equipment degradation and failure and comprehensively manage energy efficiency. This can be done by grasping the operating conditions of the equipment, keeping maintenance and inspection records and measuring energy. Fuji Electric realizes total life cycle management from the introduction through operation and replacement of equipment. It also gives strong support to customers so that they can maximize the efficiency of equipment management and minimize their energy costs.

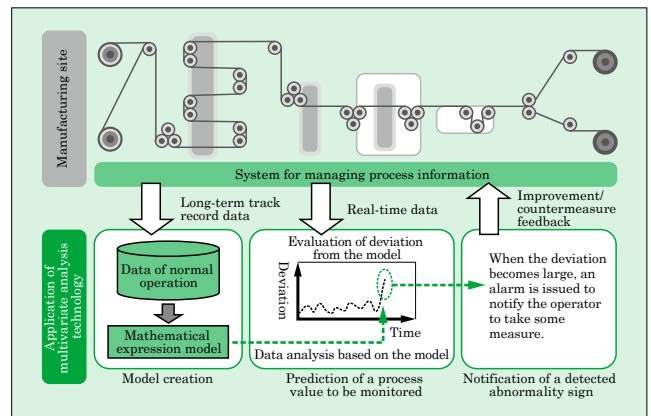
Fig.11 Comprehensive equipment management service



8 Abnormality Sign Analysis and Deterioration Diagnostic Technology by Multivariate Analysis

This technology uses enormous amounts of data generated on a daily basis by equipment and sensors. It applies multivariate analysis to detect signs of abnormality and equipment deterioration to help ensure stable operation of a plant. Generally, periodic inspections are conducted in a plant and daily checks are carried out for important equipment. However, failures may occur. One reason why signs of failures cannot be caught is that in some cases an overall change takes place gradually and cannot be detected by seeing instantaneous data. To deal with this issue, Fuji Electric has developed a technique in which a mathematical model is created from multivariate data obtained during normal operation on a monthly or yearly basis. This realizes accurate prediction and detection of signs of abnormality from a long-term perspective. As a result of applying this technique to measurement data of an actual plant, we were able to catch signs of abnormality a few hours or days before failures occurs.

Fig.12 Outline of abnormality sign analysis and deterioration diagnosis technology

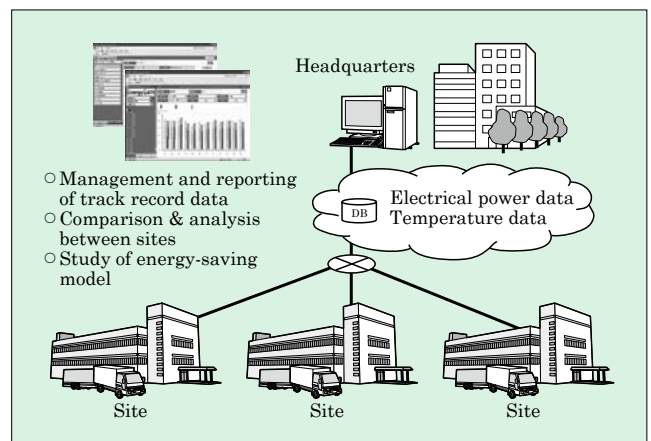


9 Integrated EMS for Refrigerated Distribution Centers

Refrigerated distribution centers that handle chilled and frozen foods require higher energy costs than dry distribution centers. This is because they must maintain the specified temperature in large spaces, and so an effective way to reduce the costs is desired. Fuji Electric has developed an integrated energy management system (EMS) for refrigerated distribution centers and started providing support services for visualization of energy usage and saving of energy as follows:

- (1) The initial cost and management cost can be reduced by making use of the cloud system.
- (2) Multiple sites can be managed in a centralized manner which helps accumulate and share energy-saving know-how by making comparisons between sites.
- (3) Making a comparison with temperature information inside the refrigerator allows for energy saving analysis in view of the actual conditions of the center operation.
- (4) The scope of visualization can be configured according to the scale of a site.

Reference: FUJI ELECTRIC REVIEW 2015, vol.61, no.3, p.182  
Fig.13 Outline of integrated EMS for refrigerated distribution centers



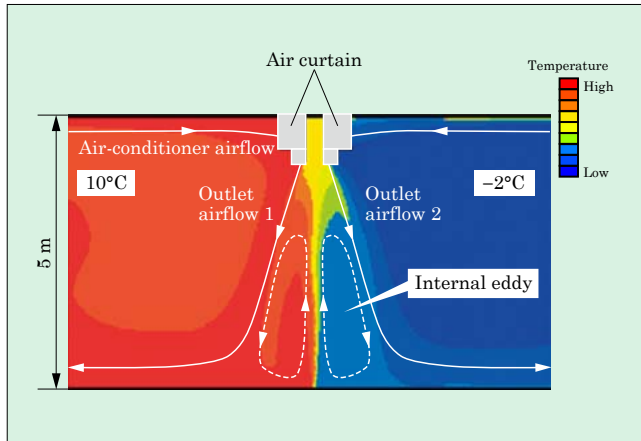
**Industrial Plants**

**10 Air Flow Control System “Zoning Air Curtains”**

For air-conditioning systems for large spaces such as refrigeration centers and plant factories, Fuji Electric has developed an air flow control system called “zoning air curtains.” It provides temperature zoning for indoor space using air flows only. This system is characterized by two air curtains installed at a specified interval. Internal eddies are induced between the air curtains by making use of the balance between the air flows out of the respective air curtains. This provides an air shutoff with two air flows that blow out and internal eddies that cause little heat transfer. Hence we have achieved a high thermal insulation effect with an improvement of 45% from the conventional system, allowing temperature zoning for indoor space.

We conducted simulation analysis of the zoning air curtains in an environment assuming a refrigerated warehouse of a refrigeration center. As a result of this, we confirmed that temperature zoning of the indoor space was realized with the targeted temperature difference of 10 K only by using air flows instead of a thermal insulation wall.

Fig.14 Result of analysis of temperature zoning simulation

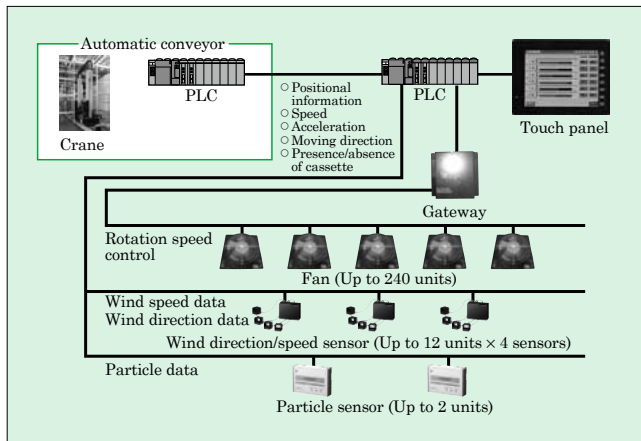


**11 Air Flow Improvement Control System for Clean Rooms**

The major source of dust in clean rooms is the drives of automatic conveyors, and maintaining cleanliness near automatic conveyors has a significant effect on the yield of products. Fuji Electric has developed a control system to improve air flow that reduces dust swirling and quickly removes dust by combining the conventional clean technology with sensing and control technologies. This system can be used to provide clean space with low energy consumption. The main features are as follows:

- (1) The positional information and speed value of an automatic conveyor are collected and applied to automatically control the rotation speed of a fan installed near a drive for reducing the swirling of dust.
- (2) The wind speed in the vertical direction is constantly monitored to determine whether there is any swirling and optimize the number of revolutions of the fan. This helps to reduce the running costs.

Fig.15 Outline of air flow improvement control system

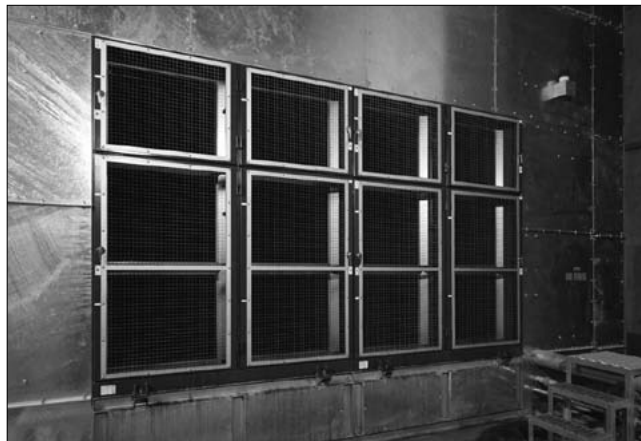


**12 Air Cleaning System for Urban Expressway Central Circular Route Shinagawa Line**

At city centers, loop roads are constructed to handle concentrated vehicle traffic and more expressways are being constructed as underground tunnels. For underground tunnels, electrostatic precipitators remove more than 80% of SPM in the air in tunnels, and denitrification equipment removes over 90% of NO<sub>2</sub>. The air is blown out high at the top of ventilation towers to be diffused. In this way, the environment in underground tunnels and around ventilation towers is maintained so that road users and local residents can be kept safe and secure.

Fuji Electric cooperated with Nishimatsu Construction Co., Ltd. to deliver the first air purification system composed of electrostatic precipitators and denitrification equipment for the Central Circular Route Shinjuku Line in 2009. Based on the results of its operation, the air cleaning system was integrated and streamlined so that it could be installed in a narrow underground tunnel. In 2015, the system was delivered for the Central Circular Road Shinagawa Line, and it helps to ensure safety and security.

Fig.16 Electric dust collector at Naka-meguro Ventilation Station



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**13 Exhaust Gas Cleaning System for Marine Vessels (Cyclone Type SO<sub>x</sub> Scrubber)**

In order to prevent air pollution resulting from marine vessels, exhaust gas regulations have been gradually reinforced based on the International Convention (MARPOL 73/78). Fuji Electric has developed an exhaust gas cleaning system for marine vessels (cyclone type SO<sub>x</sub> scrubber) compliant with SO<sub>x</sub>/PM regulations. The unit sprays alkaline water on the exhaust gas and reduces SO<sub>x</sub> by dissolving it in the sprayed droplets. The main features are as follows:

- (1) The system has the smallest size in the industry with a volume reduction of over 50% from conventional products, and was offered for testing in the joint research of Nippon Kaiji Kyokai and Imabari Shipbuilding Co., Ltd. (intended for the main engine of a new ship).
- (2) The cyclone system creates a swirl inside the unit to improve the SO<sub>x</sub> reduction rate to over 98%.
- (3) It achieves a reduction in pressure loss and the droplet dispersal rate by making use of SO<sub>x</sub> dissolution model experiments and fluid simulations.

Fig.17 SO<sub>x</sub> scrubber for 9-MW main engine (diameter 2 m, height 6 m)



**14 Equipment for Greenhouse Horticulture of Salad Paprika Co.,Ltd.**

The greenhouse horticulture of Salad paprika Co.,Ltd. is under construction in Kushiro City, Hokkaido. It is one of the largest paprika production sites in Japan with an area under cultivation of approximately 2.2 ha. Fuji Electric will deliver to the plant equipment and materials including a composite climate control system, incident light diffusing greenhouse covering material for improving the plant insolation efficiency and double-parallel-row cultivation equipment capable of improving the production efficiency. The plant aims to achieve the highest crop yield per unit area in Japan by ensuring the optimum cultivation environment, using these types of equipment. In terms of operation, a high unit price transaction can be achieved by making use of the cool climate of the area to offer stable shipping in warm seasons, in which other areas of production are having difficulty in supplying produce, and year-round supply.

In the future, we aim to expand the greenhouse horticulture business based on the cultivation environment technology, know-how on cultivation business operation and EPC experience with a large-scale greenhouse horticulture, to be acquired at this plant.

Fig.18 Greenhouse horticulture (under construction)



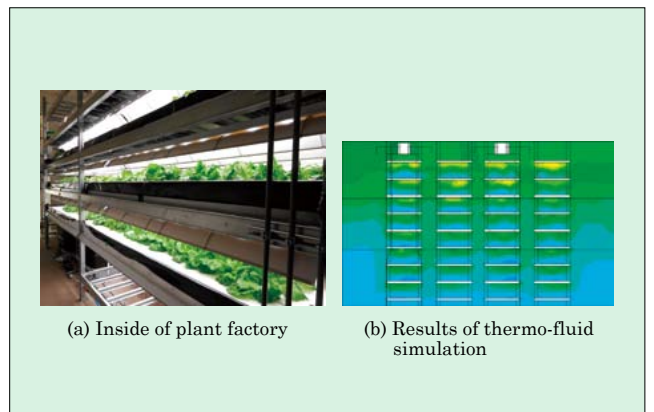
**15 Air-Conditioning System for Complete Artificial Light Plant Factory**

As the stable supply of food has come to be regarded as important recently, complete artificial light plant factories, which do not depend on the season or climate and allow multi-tier cultivation, are attracting attention.

Fuji Electric has taken advantage of its thermo-fluid analysis technology and delivered to a certain customer an air-conditioning system for a complete artificial light plant factory. It homogenizes temperature in a facility, which is especially important for stable production of crops. The main features are as follows:

- (1) Optimum device capacity has been specified in a thermal load calculation with the transpiration of plants and heat generation load of lighting taken into account.
- (2) Thermo-fluid simulation based on the physical conditions such as the passage width and aperture ratio of vents has been conducted. This has determined the temperature distribution and wind speed distribution in the facility so that an air-conditioning system with appropriate capacity and layout can be provided.

Fig.19 Inside of plant factory and results of thermo-fluid simulation

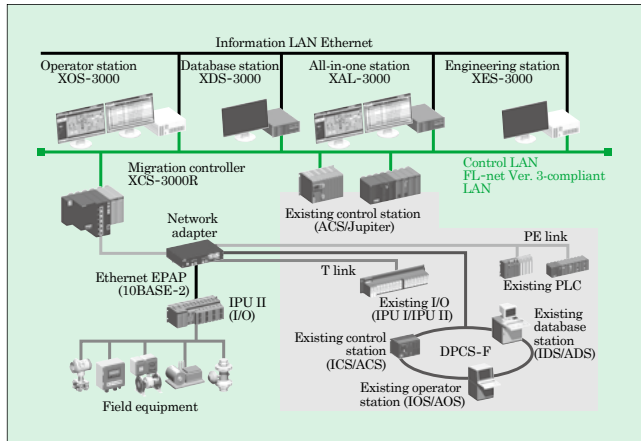


## Industrial Plants

### 16 Product Line Expansion of Small- and Medium-Scale Monitoring and Control System “MICREX-VieW XX”

Fuji Electric has developed the “MICREX-VieW XX migration system” with ensured compatibility with the conventional “MICREX Series” and the all-in-one station “XAL-3000.” The MICREX-VieW XX migration system can connect to existing networks and I/O through a network adapter, saving the labor of wiring work. In addition, making use of the existing system screens and controller applications means an existing system can be updated to a highly reliable one in a short time. XAL-3000 integrates the operator station “XOS-3000” and database station “XDS-3000” into one unit. It can be used to construct a small system capable of reducing the initial introduction and maintenance costs in total while ensuring high reliability by redundancy.

Fig.20 “MICREX-VieW XX migration system”

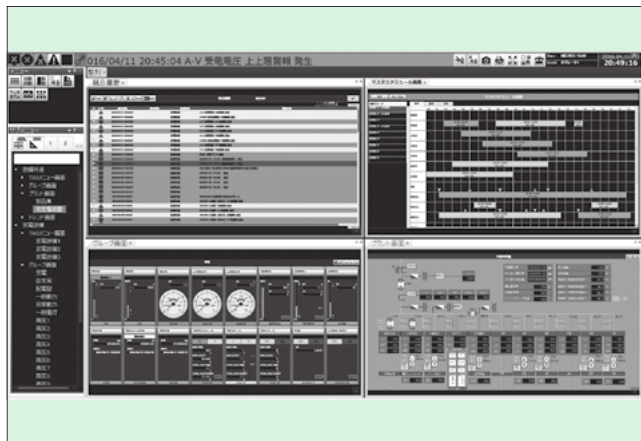


### 17 Equipment Monitoring System “MICREX-VieW PARTNER”

Fuji Electric has developed equipment monitoring system “MICREX-VieW PARTNER.” It is at the core of level II of the ISO energy management hierarchy that connects level III (EMS) and level I (collection device). The main features are as follows:

- (1) Energy management systems can be seamlessly built in the equipment alone, line or entire factory or between factories due to the strengthened vertical and horizontal integration.
- (2) Addition or renovation of systems is easy and the monitoring points can be simply configured from either the upper or lower level.
- (3) The operator access control function based on the latest ICT has achieved improved operability and reinforced security.
- (4) The same operation as that for the small- and medium-scale monitoring and control system “MICREX-VieW XX” can be used, which mitigates the burden of operator training by employer.

Fig.21 Example of operation screen

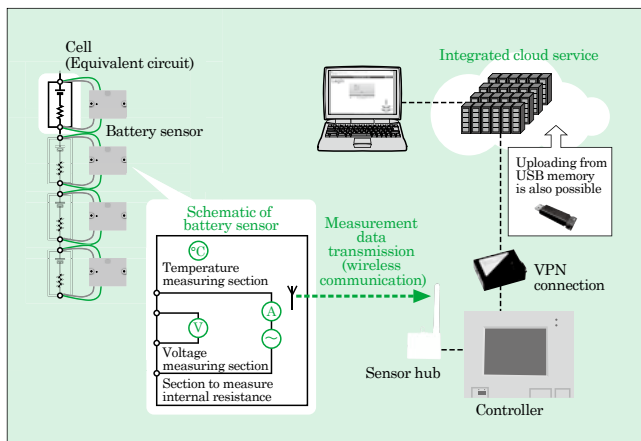


### 18 Cloud-Based Battery Diagnosis Service

Fuji Electric offers “Integrated Cloud Service” in the field of equipment maintenance, utilizing the IoT and M2M. The cloud-based battery diagnosis service ensures the stable operation of equipment that requires batteries. Measurement for each electric cell is possible and the voltage, internal resistance and temperature of valve-regulated batteries are continuously monitored to detect any characteristic change of the batteries, which allows abnormalities or aging degradation to be grasped. The main features are as follows:

- (1) Loss resulting from unexpected failure can be avoided.
- (2) Signs of degradation can be detected to make repair and replacement plans.
- (3) Prediction management through an annual or biannual inspection can be changed to maintenance management by constant monitoring.
- (4) The replacement time can be predicted with numerical trend management to reduce risks and costs.

Fig.22 Outline of cloud-based battery diagnosis service



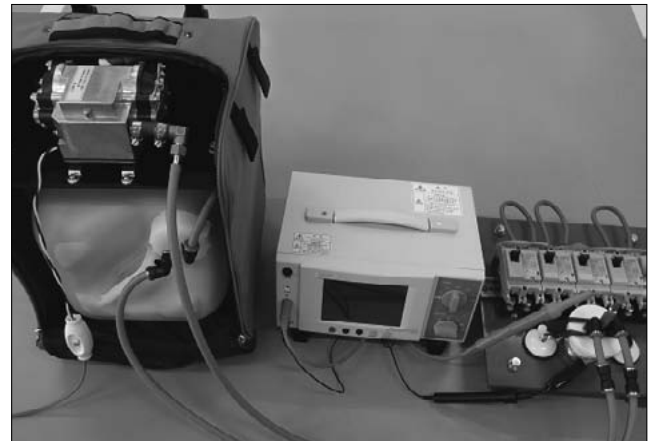
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### 19 Insulation Diagnosis Service by Surface Resistance Measuring Device

For distribution equipment that has been in use for a long time, identifying appropriate replacement time is important and insulation diagnosis technology is desired for that purpose. With existing diagnosis techniques, surface resistance at high humidity is estimated based on the usage environment and analysis of deposits. Problems with this technique includes that the accuracy of the surface resistance cannot be assured, lab analysis is required and the cleaning effect cannot be applied.

Fuji Electric has developed a surface resistance measuring device capable of on-site direct measurement of the surface resistance of the insulator of the distribution equipment installed under arbitrary humidity conditions. The accuracy of the surface resistance can be assured and the surface resistance restoration effect by cleaning in periodic inspections and degradation characteristic (remaining life) of the insulator can be grasped. We will offer a new insulation diagnosis service by using this device.

Fig.23 Surface resistance measuring device



## Industrial and Instrumentation Equipment

### 1 New Electronic Personal Dosimeter "NRF50"

Fuji Electric has developed a new electronic personal dosimeter "NRF50," which reflects market needs. NRF50 has characteristics that conventional products do not have, such as a large dot LCD, radio communication module and emergency call button. In addition, it is compliant with IEC 61526 Ed3.0 and ANSI N42.20, which are international standards for dosimeters, and combines the electromagnetic compatibility (EMC) performance that satisfies MIL-STD-461F, water-proof performance of IP65/67 and high robustness. For radio communication, either 900-MHz radio or Wi-Fi can be selected and the real-time remote monitoring system can reduce exposure of workers to radiation. In addition to use in nuclear facilities, this dosimeter is expected to use for decontamination and measures against radiation terrorism.

Fig.24 "NRF50"



### 2 Analog Circuit Pressure Transmitter for Special Applications

Fuji Electric has developed an analog circuit pressure transmitter with excellent radiation resistance for nuclear power plants. Currently, for control and monitoring, petroleum, chemical, steel and power generation and other industry plants mostly employ digital circuit transmitters equipped with a microcomputer. However, highly-integrated semiconductors are easily affected by radiation, and at nuclear power plants, they are only used in low-radiation areas. Analog circuit transmitters are capable of meeting requirements that cannot be satisfied by digital circuit transmitters. The main features are as follows:

- (1) Radiation resistance: Adopting electronic components with a high radiation resistance and circuit structure have achieved a radiation resistance of 50-kGy irradiation.
- (2) High temperature resistant characteristic: A high temperature resistant characteristic of 125°C has been provided assuming a coolant leak accident.
- (3) Seismic vibration: The structural design ensures resistance to an acceleration of 5 G.

Fig.25 Analog circuit pressure transmitter



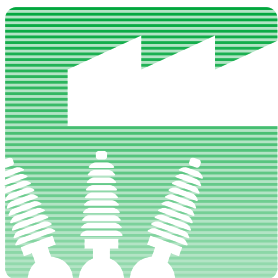
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### ③ High-Accuracy Spool Piece Ultrasonic Flowmeter “FST”

The high-accuracy spool piece ultrasonic flowmeter “FST” contributes to energy saving and quality improvement by accurately measuring various liquids with multipath (3 paths) and its scope of application is expected to expand. The main features are as follows:

- (1) It can measure fluids with very high accuracy by using three pairs of ultrasonic sensors installed facing each other in piping together with our proprietary digital signal processing technology and arithmetic algorithm.  
Accuracy:  $\pm 0.2\%$  of rate (flow velocity: 1 to 10 m/s)
- (2) It can measure oil, deionized water and other low-conductivity liquids which are difficult to measure with electromagnetic flowmeters.
- (3) Measurable fluid temperature of FST is higher than that of an electromagnetic flowmeter.  
Fluid temperature:  $-40^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$

Fig.26 “FST”





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