

## 1 "Green" Design

We are working on setting up an infrastructure that facilitates "green" design, namely, the design of environmentally friendly products. As the standards for assessments, we added a set of green design and other criteria to complement our conventional design review standard. Engineers in the product design departments can use PC's to freely access various Yokogawa standard engineering tools, thus facilitating environmentally friendly design and engineering.

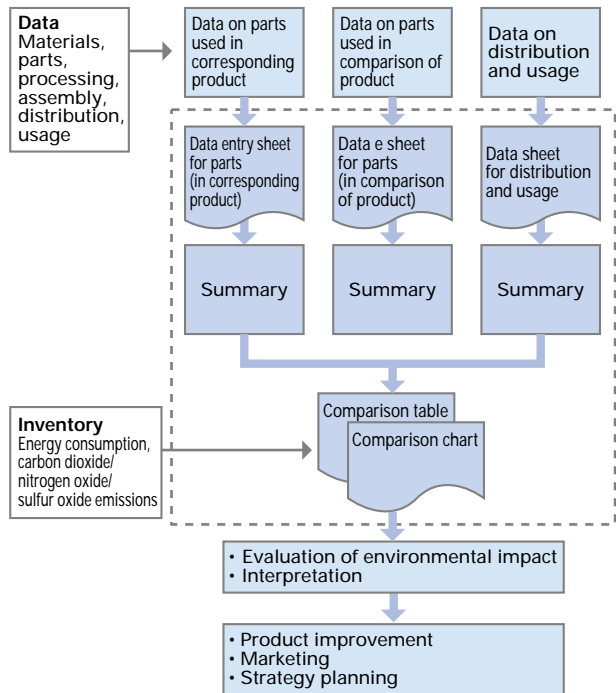
### Design Support Tools

In 1997, we began enhancing the guidelines and standards for engineers by including how to engineer and design environmentally friendly products as well as how to assess them. In fiscal 1999, we issued a life-cycle assessment standard.

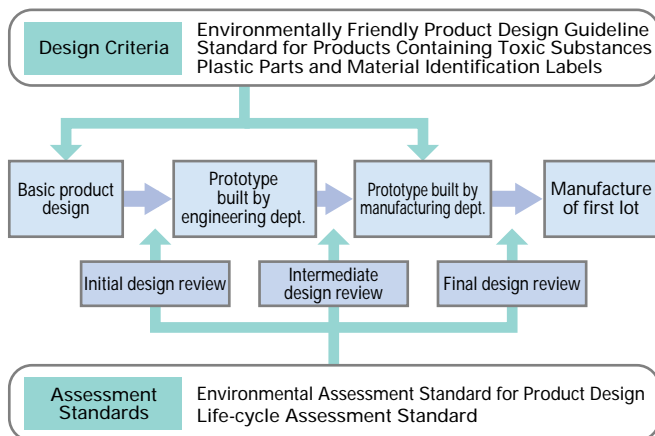
### Life-cycle Assessment Standard

A life-cycle assessment, LCA for short, is a method to comprehensively evaluate the impact of a specific product on the environment throughout the lifecycle of the product, from material purchase, manufacture, and distribution to its use and disposal. We have developed an LCA tool for assessing a product quantitatively on a micro level in respect to energy consumption and carbon dioxide emissions. For the database, this tool uses NIRE-LCA from the Institute of Resources and Environment Technology in Japan. Similar to the environmental assessment standard for product design, the life-cycle assessment standard is implemented from the early stages of design for every product. We set a reduction in carbon dioxide emissions of 25 percent as the guideline for improvement, and our aim is to incorporate this reduction in the impact on the environment in future designs.

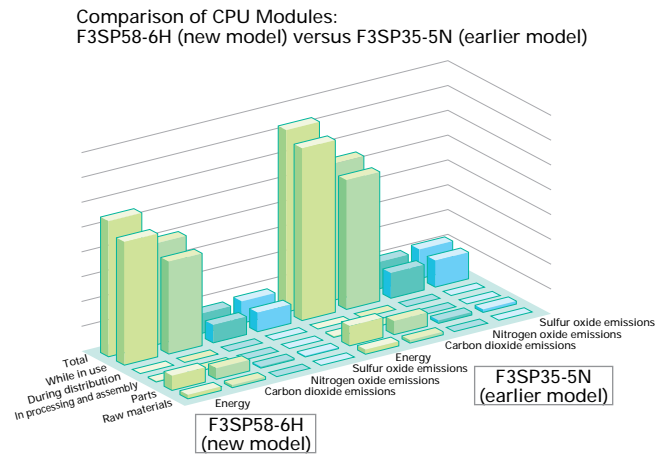
### ■ Configuration of LCA Tool



### ■ Design Criteria and Assessment Standards



### ■ Example Configuration of LCA Tool



## Examples of Benefit of Green Design

### Example 1: DAQSTATION DX200

The DAQSTATION DAQ200, a true "zero emissions" recorder that does not consume chart paper, recording pens, or ink ribbon cassettes, was released. Instead of using recording charts and pens, the DAQ200 has a color 10.4-inch LCD and removable-media slot (for either a floppy disk, memory card, or ZIP disk). It thus consumes neither paper, ink, nor resin. Not only this, the number of parts has decreased dramatically, and the leadtime for assembly and disassembly has been cut accordingly. The result of an environmental assessment shows that the DAQSTATION DAQ200 paper-free recorder has improved by 42 percent in comparison to its predecessor, the mR1800 chart recorder.



DAQSTATION DX200

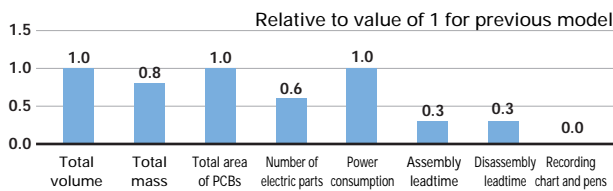
### Example 2: Aeronavigational LCD Meter

An aeronavigational LCD meter is installed in an airplane cockpit and provides integrated, graphical navigational information, including the airplane's attitude, speed, and altitude. From a previous design, we reduced the power consumption by reviewing the internal circuitry and parts used, and also reduced the amount of aluminum used by changing from parts shaved from an aluminum block to worked sheet metal. In the new model, this resulted in a 33-percent reduction in the power consumption and a 35-percent reduction in the aluminum used.

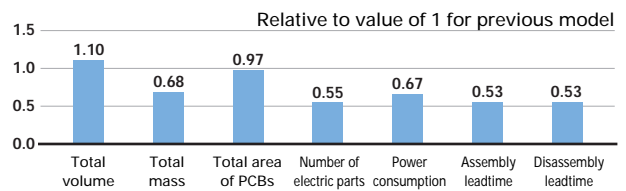


Aeronavigational LCD Meter

### ■ Comparison of New DX200 and Earlier mR1800



### ■ Comparison of New and Previous Aeronavigation LCD Meters



## 2 "Green" Production

The Yokogawa Group has been implementing "Environment, Quality, Delivery, Cost" activities (E+QDC) to minimize the use of energy and resources and thus help protect the environment.

To minimize—ideally, eliminate—the environmental impact of constructing a manufacturing line, the manufacturing process is designed at the same time as the product itself, from the outset of the product planning phase, by a team including the developer of the product. Based on this idea, Yokogawa revised the production process engineering standard to include environmental considerations. This standard is linked to Yokogawa's production system, NYPS, and extends to all Group companies worldwide to achieve environmentally friendly production throughout the Yokogawa Group. Some examples of our "green" production are shown below.

### Example 1: Single Worked Sheet-metal Part

The Kofu plant succeeded in changing a frame assembly composed of 42 separate parts to a mainframe made out of a single worked aluminum sheet. This success not only resulted in a 40-percent reduction in the product weight from the previous design, but also enabled the overall mechanical structure to be strengthened by assembling it together with a plastic mold cover.



Single worked sheet-metal part

### (2) Measures for Phasing Out Trichloroethylene

To phase out trichloroethylene, we studied a method for assessing cleaning quality and a cleaning method meeting the requirements from production lines, and then developed cleaning machines with a minimal environmental impact and employed them in the production lines.

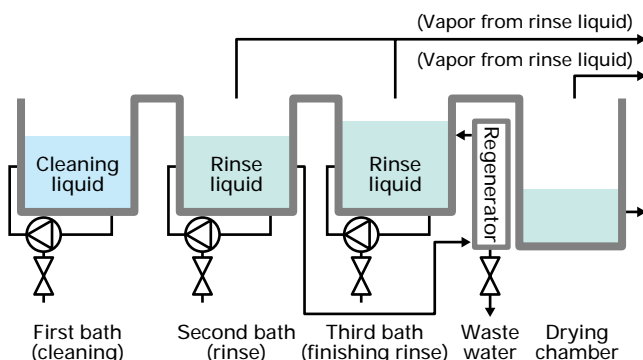


Machine to clean parts with hot water before they are coated

### Example 2: Environmentally Friendly Cleaning Methods

**(1) Establishment of Cleaning System Using HCFC Substitute**  
The Montreal Protocol on Substances That Deplete the Ozone Layer decided to phase out HCFCs, which have been labeled "second-generation freon" since they also deplete the ozone layer. The Yokogawa Group has been using HCFCs to clean off excess soldering flux from printed boards; however, the Group was able to decrease the use of HCFCs to two-thirds by establishing a processing method that needs no cleaning. In addition, there are plans to phase them out since we have confirmed several substitute cleaning systems. At Yokogawa Headquarters and Yokogawa Electronics Corporation, HCFCs have been phased out from three lines mainly in processed-part cleaning processes.

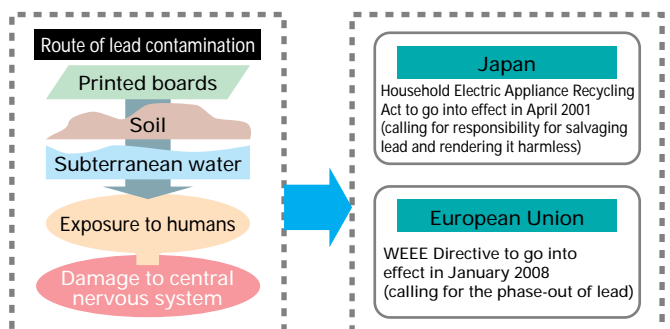
#### ■ Flow Diagram of One Substitute Cleaning System



### Example 3: Challenge of Making Practical Use of Lead-free Solder

In comparison to conventional lead-based solder, using lead-free solder while assuring quality on a practical level imposes many hurdles that need to be overcome, such as the high melting temperature, the large amount of oxides generated, and the low soldering performance. To enable parts greatly differing in heat capacity to be soldered automatically on the same printed board, a comprehensive study of part-mounting technology is being conducted, including soldering flux, electronic parts, printed boards, the soldering facility, and pre-soldering treatment process. At present, we have established a lead-free soldering system for single-sided printed boards that could possibly be put into practice.

#### ■ Trend of Legal Regulations Involving Lead

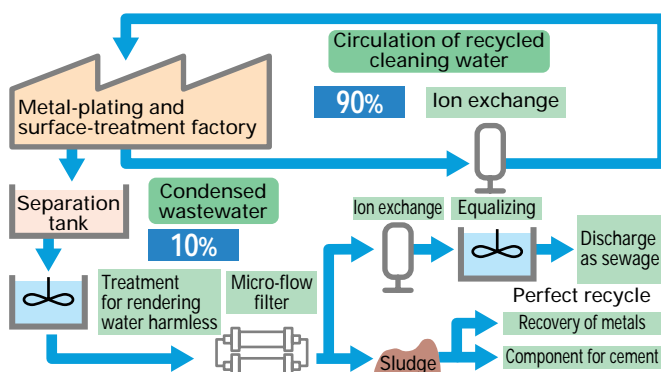


### Example 4: Wastewater Treatment Facility Rendering Wastewater Totally Harmless

At Headquarters, as the printed board manufacturing facility was relocated to a different plant, the wastewater treatment facility was renovated. The new facility employs a precision treatment system that renders harmless wastewater from metal-plating processes before discharge, and recycles the separated and precipitated sludge. The merits are many: the plant area is reduced to a quarter of its original size; dual-redundant underground tanks assure the prevention of leakage; wastewater discharge is greatly reduced by circulating recycled cleaning water; the shower washing and multi-phase cleaning methods minimize wastewater discharge from metal-plating lines; and the fractional treatment, depending on the intake route (from ten routes distinguished by the water quality), reduces the use of toxic chemicals and improves the quality of water rendered harmless. In particular, the discharge filtered through a state-of-the-art micro-flow filter contains almost no neutralized metals in comparison to discharges from

the conventional precipitation method, thus dramatically improving the quality of water discharged as sewage. From the dehydrated sludge, a recycling company recovers metals, and the slag is used as a component of cement, thus achieving "zero emissions".

#### Water Treatment Facility



## 3 "Green" Plants and Offices

The use of electric power and municipal gas supplies emits carbon dioxide, nitrogen oxide compounds, and sulfur oxide compounds, which cause the global warming effect, air pollution, and acid rain. Also, the waste and wastewater discharged from production processes are involved in various environmental issues. The Yokogawa Group is therefore committed to reducing the environmental impact of its plants and offices. The trend in this reduction is shown below.

(Note: One reason for the decrease in energy and the amount of waste in fiscal 1999 is due to the relocation of the printed-board manufacturing facility away from Headquarters).

### 1) Energy Efficiency

Our production plants have been increasing their energy efficiency with upgraded production technologies and facilities, by implementing careful energy control. Furthermore, heating and cooling equipment was replaced with energy-efficient yet environmentally friendly equipment; other similar equipment has been employed in consideration of achieving minimal gas emissions.

#### Examples of Activities to Increase Energy Efficiency

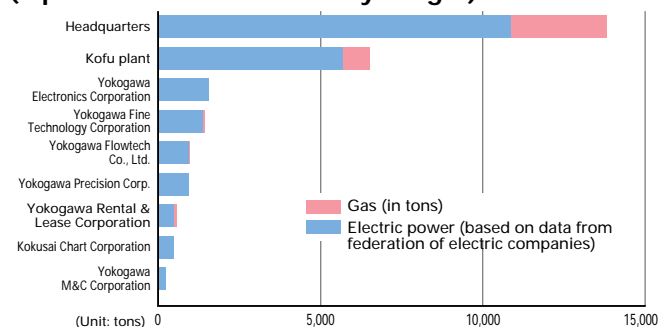
##### At Headquarters

- Increased percentage of power generated by co-generator
- Installed economizer transformers
- Changed to inverter-driven air-conditioning equipment and fans

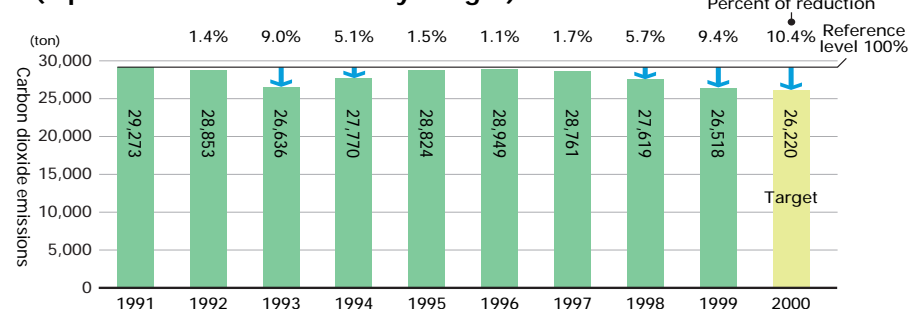
##### At Kofu plant

- Managing operations by power monitoring
- Controlling number of running compressors
- Changed to inverter-driven pumps and fans

#### Carbon Dioxide Emissions in Energy Consumption (equivalent carbon dioxide by weight) for Fiscal 1999



#### Trend of Total Carbon Dioxide Emissions in Energy Consumption (equivalent carbon dioxide by weight) at Nine Sites

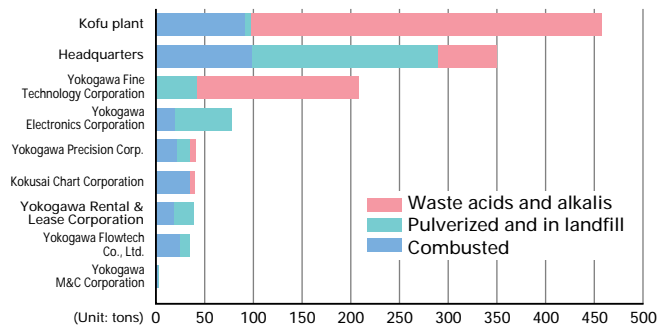


## 2) Reduction of Waste Excluding Recycled Materials

There are four methods for disposing of industrial waste materials: separation of recyclable materials, neutralization to render waste materials harmless, burning of combustible waste materials, and disposal of noncombustible waste materials in landfills. To achieve zero waste, the Yokogawa Group is boosting its push to limit the generation of waste, and to recycle that which is produced.

We have decreased landfill waste by calling for a thorough separation of recyclable waste materials under the slogan "Mix it up and it's waste; separate it and it's a resource." In our effort to achieve "zero landfill waste," the remaining noncombustible waste material is recycled using a gasifying fusion furnace. Yokogawa Headquarters was the first site to reach this target in July 2000. The other sites will follow.

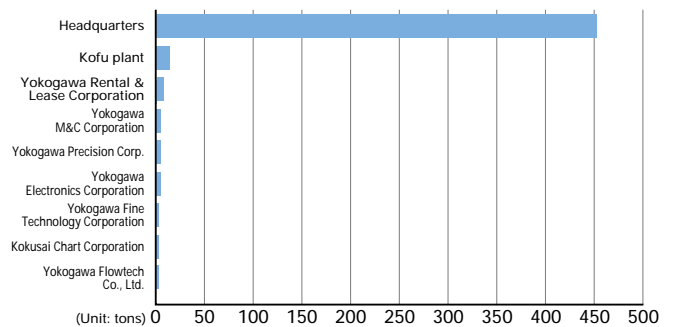
### ■ Reduction of Waste (Excluding Recycled Materials) in Fiscal 1999



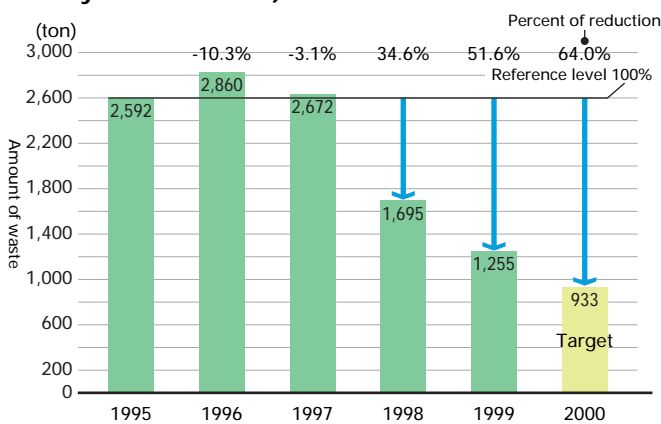
## 3) Reduction of Paper Consumption

Regarding forest resources, we are progressively reducing paper consumption and using recycled paper for office use, business cards, and publications. This is being done by increased computer use and networking to construct paperless systems, such as distributing documentation by CD-ROM through our global network.

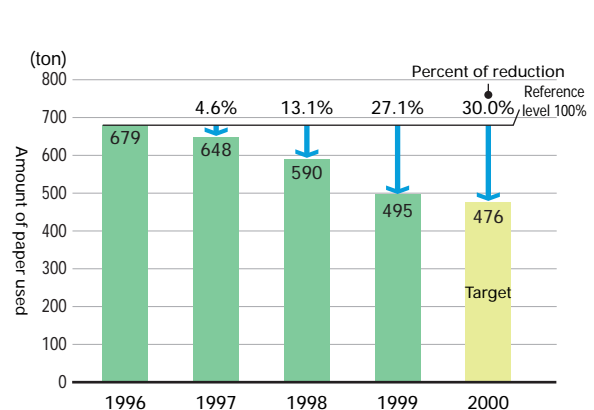
### ■ Reduction of Paper Consumption in Fiscal 1999



### ■ Trend of Total Amount of Waste (Excluding Recycled Materials) at Nine Sites



### ■ Trend of Total Paper Consumption at Nine Sites



## 4 "Green" Purchasing

To deliver products to customers, Yokogawa needs to purchase materials and parts as well as subcontract out machining and assembly. The impact on the environment must also be minimized in these activities, so the Yokogawa Group carries out extensive "green" purchasing activities that intentionally help protect the environment while abiding by three rules: comply with regulations; conclude "fair and square" purchasing transactions; and follow the "open-door principle."



### 1) "Green" Purchasing Activities

To purchase materials, parts, and products that have a low impact on the environment, our procurement department is asking materials and parts suppliers and machining subcontractors to cooperate to protect the environment in line with Yokogawa's environmental policy. As "green" purchasing activities in fiscal 1999, the procurement department did the following:

- Chose those vendors that account for the top 70 percent of the total amount of purchases and sent a survey to 68 selected materials and parts suppliers and 51 machining subcontractors on their situation with environmental protection activities. The survey included the surveyed companies' accreditation status for an environmental management system, corporate mission, organization, legal compliance, status of environmental monitoring and management, training and education for emergency situations, logistics and packing, and various aspects of environmental impact.
- Evaluated the 61 materials and parts suppliers and 49 machining subcontractors that responded to this survey, placed them in one of three categories (A, B, or C) in respect to their true situation with environmental protection activities, and recorded the results in the purchase management system.
- Requested the vendors selected from those that were evaluated to cooperate to protect the environment in line

with Yokogawa's environmental policy, encouraged them to take concrete measures to reduce their impact on the environment and to implement other environmental protection measures such as the effective use of energy, compliance with legal controls, and reduction in the use of toxic and harmful substances.

- Visited seven machining subcontractors and encouraged them to take specific measures to reduce their impact on the environment.

### 2) "Green" Purchasing of Stationery, Paper, and Office Equipment

Among office supplies that include paper, stationery, and office equipment, 72 out of 117 items were regarded to come under ecological considerations, and 66 replaceable items (92 percent of the 72) were replaced with "eco-goods." Also, the company's mailing envelopes were reviewed and replaced with ones made with fifty-percent-



Examples of a "Green" Goods Purchase

recycled paper. Furthermore, there is an activity underway to switch the copy paper from wood-free paper made of recycled paper to "green-certified" paper with the eco-mark that has a brightness level of 70.

## 5 " Green" Packing

**Foam plastic and Styrofoam have been used as cushioning materials the most for electronic measuring instruments of all Yokogawa Group products. We set these products as the first target, and studied the feasibility of using pulp mold and film cushions to promote the use of recyclable packing materials and to reduce the types of packing materials. After conducting various tests to assess the reliability, we have begun switching to those materials.**

### 1) Pulp Mold Cushions

Pulp molds are molded from liquefied waste paper and used as packing cushions. We use pulp mold cushions to pack products that weigh five kilograms (11 pounds) or less, that are manufactured in quantities of at least 300 per month, and that can withstand 60 G (equivalent to a free fall from a height of 120 cm).

### 2) Film Cushions

Film cushions are made of rugged, elastic, non-slip sheets of film adhering to a cardboard frame. A product is supported by two sheets of film that absorb shock, and floats in a package. Due to their flexibility, film cushions are widely used for computer-related devices in the United States and Japan. Film cushions can be used for a large number of products as long as the elasticity of the film works effectively for the size and weight of the product. The sheets of film can be easily peeled off from the cardboard and, above all, they can be incinerated at a low temperature since this produces no toxic gases.



Pulp Mold Cushions Used for Packing a  $\mu$ R1000 Recorder



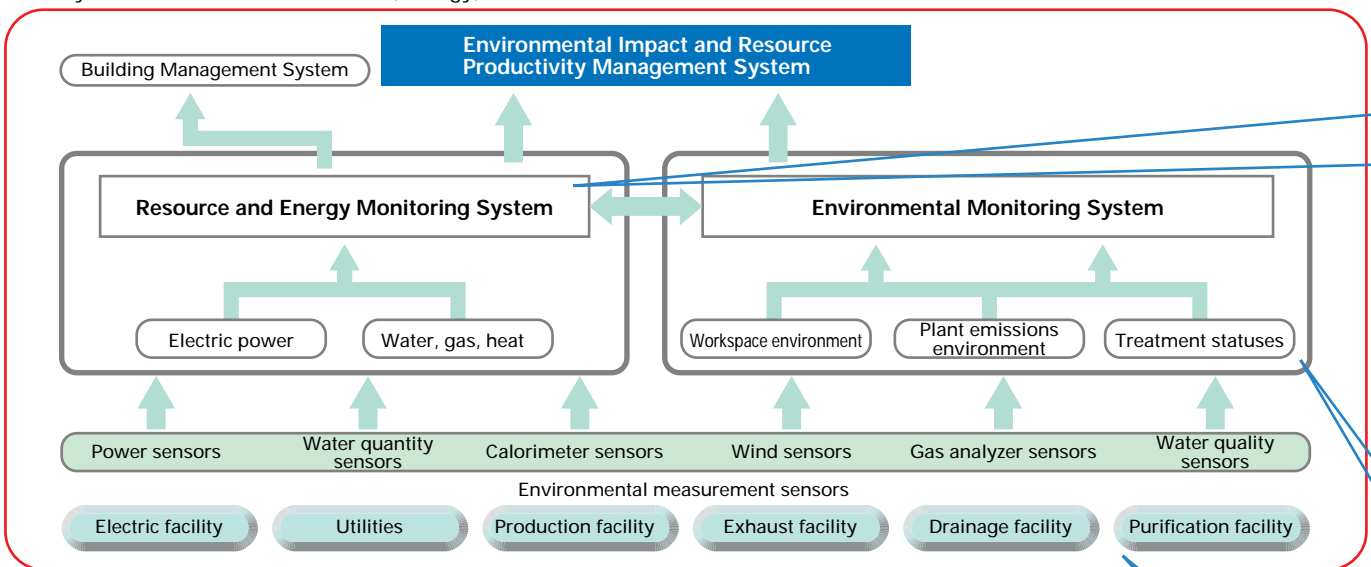
Film Cushions Used for Packing a DL1500 Digital Oscilloscope

## 6 "Green" Solutions

From now on, the Yokogawa Group will not merely be supplying environmentally friendly products originating from "green" design but will also provide "green" solutions that incorporate the expertise gained through our environmental management activities. Offered to customers, these solutions will help the customers reduce their impact on the global environment resulting from their production and social activities and will further aid them in achieving a sustainable society. The environmental impact and resource productivity management system is a compilation of "green" solutions from the Yokogawa Group.

### ■ Configuration of Environmental Impact and Resource Productivity Management System

The system consists of two subsystems—the Resource and Energy Monitoring System and the Environmental Monitoring System—that connect to resource, energy, and environmental sensors.



The microbe wastewater treatment system is an innovative system in which microbes having a strong ability to decompose substances are activated and multiply, and are then automatically added to the water depending on the amount flowing through the drain. By selecting a specific microbe to be used, this system can be adapted to wastewater with any kind of composition, and exhibits a high performance despite the small space it takes up.

### Water Purity Improvement System

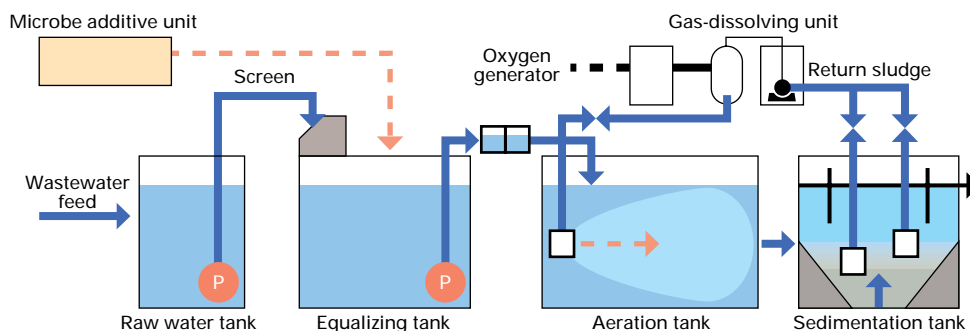
The microbe wastewater treatment method can increase its throughput and slash the amount of excess sludge by operating an aeration tank with a high concentration (15,000 mg/L) of mixed liquor suspended solids (MLSS). For this, it is necessary to efficiently increase the dissolved-oxygen concentration. This system recycles the return sludge through a gas-dissolving unit to supply a high concentration of oxygen to it and returns the activated sludge to the aeration tank. There is no need for more than one tank because of the efficient gas-dissolving unit.

#### Comparison to Activated Sludge Method

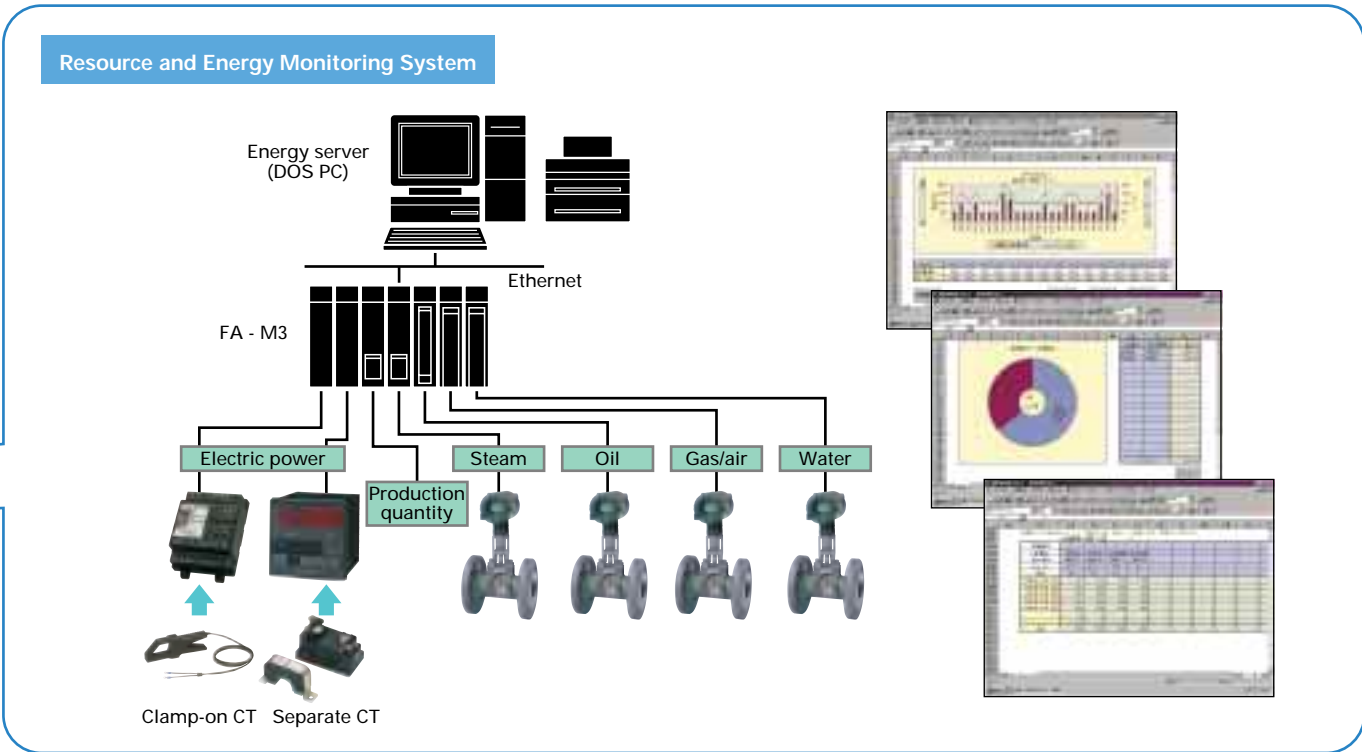
	Activated Sludge Method	Microbe Method
(1) Raw water conditions		
BOD	2000 mg	Unlimited
n-hexane	100 mg	500 mg
(2) Ratio of volume of each tank	4	1

**Note:** In a microbe wastewater treatment system, each tank only needs to be one quarter the size of a tank in the activated sludge method. In addition, it does not require oil separation, nor fat and oil storage tanks, and it allows the design for sludge storage and the dehydrator to be minimal sizes.

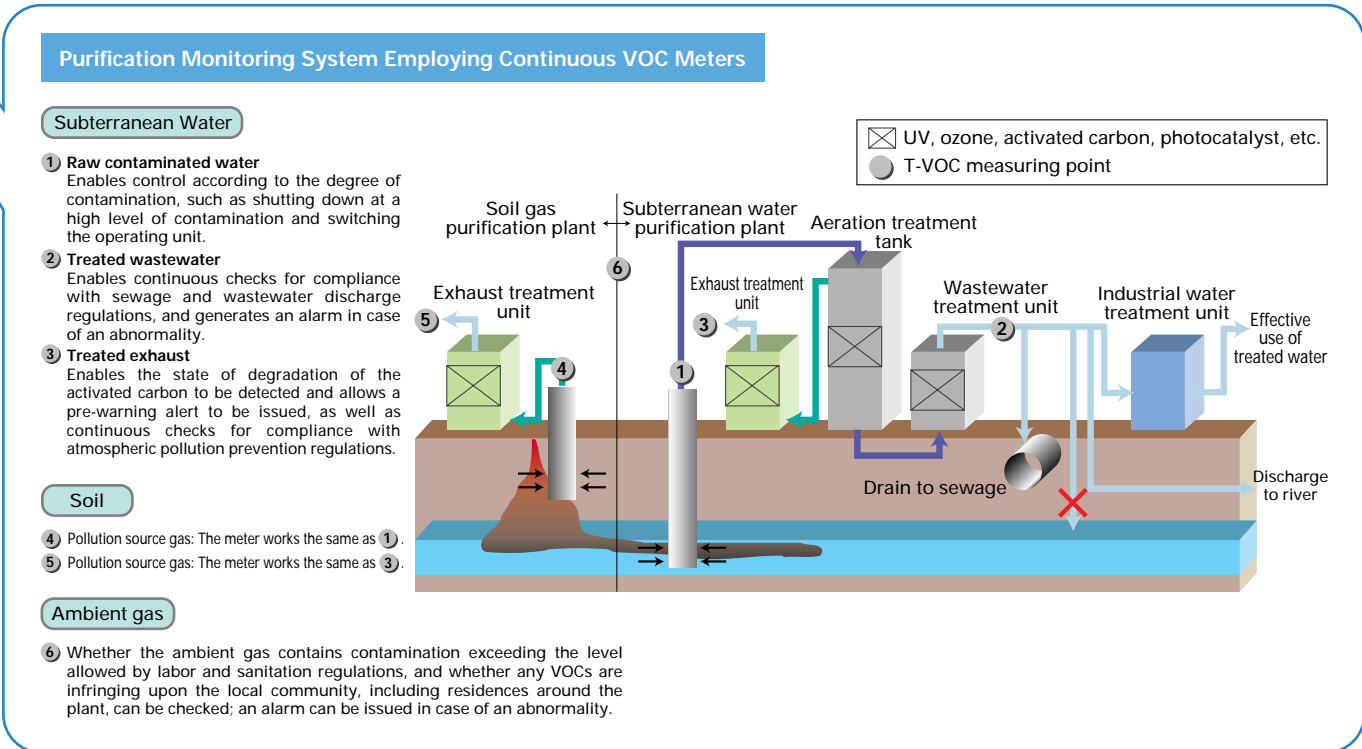
#### Example of Wastewater Treatment Flow



A power monitoring system is already running at Yokogawa's Kofu plant. If utilities such as water, gas, and the energy spent for area heating and cooling are included in monitoring, it will become a Resource and Energy Monitoring System.



Yokogawa's analytical sensors are used effectively elsewhere in a customer's various production facilities and utility facilities, such as for electric power, and facilities for environmental measures. Shown below is an example of configuration of a purification monitoring system employing continuous VOC meters in soil and subterranean water purification facilities.





## 7 Compliance with Regulations

### 1) Environmental Data at Each Site (fiscal 1999)

The tables below show the emissions measured at each site containing a specific facility that has a high impact on the environment. The measured values are compared with the limits allowed by the respective municipal regulations. (Note: "ND" indicates not detectable, i. e., "below the detectable limit.")

#### Headquarters: Musashino-shi, Tokyo, Japan (in semi-industrial zone)

##### ■ Atmosphere

Substance	Facility	Legal Limit	Max. Measured Value
Nitrogen oxides (ppm)	Cooling/heating water generator	150	70
	Gas engine	600	214
Smoke and dust (g/Nm <sup>3</sup> )	Cooling/heating water generator	0.03	0.0006
	Gas engine	0.04	0.0007
Hydrogen chloride (ppm)	Scrubber	25	ND
Sulfuric acid (mg/Nm <sup>3</sup> )	Scrubber	1	ND
Trichloroethylene (ppm)	Cleaning bath	100	25
Tetrachloroethylene (ppm)	Cleaning bath	100	35

##### ■ Water Purity

Substance	Legal Limit	Max. Measured Value
Cyanide (mg/liter)	1	ND
Hexahydric chromium (mg/liter)	0.5	ND
Copper compounds (mg/liter)	3	0.03
Fluorine compounds (mg/liter)	15	12.3
All kinds of chromium compounds (mg/liter)	2	0.14
Trichloroethylene (mg/liter)	0.3	ND
Tetrachloroethylene (mg/liter)	0.1	0.0017

#### Kofu Plant: Kofu-shi, Yamanashi Pref., Japan (in industrial park)

##### ■ Atmosphere

Substance	Facility	Legal Limit	Max. Measured Value
Nitrogen oxides (ppm)	Cooling/heating water generator	150	66
Sulfur oxides (Nm <sup>3</sup> /h) - K-value limit	Cooling/heating water generator	2.78	ND
Smoke and dust (g/Nm <sup>3</sup> )	Cooling/heating water generator	0.1	ND

##### ■ Water Purity

Substance	Legal Limit	Max. Measured Value
Cyanide (mg/liter)	0.1	ND
Hexahydric chromium (mg/liter)	0.05	ND
Copper compounds (mg/liter)	1	0.14
Fluorine compounds (mg/liter)	1	0.8
All kinds of chromium compounds (mg/liter)	0.5	ND
Trichloroethylene (mg/liter)	0.3	ND

### 2) Handling of Toxic Substances – Implementation of Pollutant Release and Transfer Registers (PRTRs)

Following the world trend, Japan has also enacted Pollutant Release and Transfer Registers (PRTRs) which will take effect starting in April 2001. As the control of chemicals becomes increasingly more important, the Yokogawa Group is aggressively striving to boost its respective activities to reduce environmental impact, such as prohibiting the use of some of these substances and reducing the amounts used.

#### Yokogawa Fine Technology Corporation: Akiruno-shi, Tokyo, Japan (in industrial park)

##### ■ Atmosphere

Substance	Facility	Legal Limit	Max. Measured Value
Hydrogen chloride (ppm)	Scrubber	25	ND
Cyanide (ppm)	Scrubber	10	ND
Trichloroethylene (mg/Nm <sup>3</sup> )	Cleaning bath	500	180
Toluene, xylene (ppm)	Coating	200	13

Water Purity: Yokogawa Fine Technology has employed a wastewater treatment system that does not discharge into a drain; hence, measured data for wastewater is unavailable.

#### Yokogawa Flowtech Co., Ltd.: Hisai-shi, Mie Pref., Japan (in industrial park)

##### ■ Atmosphere

Substance	Facility	Legal Limit	Max. Measured Value
Nitrogen oxides (ppm)	Once-through boiler	130	33
Smoke and dust (g/Nm <sup>3</sup> )	Once-through boiler	0.18	0.0028
Sulfur oxides (Nm <sup>3</sup> /h) - K-value limit	Once-through boiler	0.65	0.009

##### ■ Water Purity

Substance	Legal Limit	Max. Measured Value
Trichloroethylene (mg/liter)	0.3	0.22

#### Yokogawa Electronics Corporation: Haramachi-shi, Fukushima Pref., Japan (in industrial park)

##### ■ Atmosphere

Substance	Facility	Legal Limit	Max. Measured Value
Nitrogen oxides (ppm)	Boiler	180	76
Smoke and dust (g/Nm <sup>3</sup> )	Boiler	0.3	0.046

Out of the 354 controlled substances under the PRTR system, Yokogawa uses seven of them for which releases and transfers must be reported to the government. The total amounts used of each of these seven substances in fiscal 1999 at the nine aforementioned sites are shown on the right.

(Fiscal 1999)

Substance	Total Amount Used at Nin Yokogawa Group Sites (tons)
Cyanide	3.1
Toluene	9.2
Xylene	11.5
Trichloroethylene	27.4
Tetrachloroethylene	2.4
Dichloromethane	1.4
Formaldehyde	0.7