SUPERVISORY CONTROL SYSTEM FOR KANAMACHI FILTRATION PLANT, TOKYO METROPOLITAN WATERWORKS

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1. FOREWORD

The Kanamachi filtration plant is located on the right bank of the Edo River about 17.5 km above the mouth. This filtration plant started operation in August 1926 and since then, has become the largest in the Far East through a number of expansions.

The treated clean water is stored in nine clean water reservoirs and is supplied to the eastern and central regions of Tokyo through 10 service pipelines by three pumping stations. Conventionally, supervisory control of water-conveyance and distribution facilities was performed by individual manned management at the No. 3, No. 4, and No. 5 pumping stations. However, the recent increase in the demand for water was accompanied by the introduction of a supervisory control system using a data processing system for more efficient pump operation management and higher facility reliability.

This system centrally batch manages the three distributing pump stations, plant valuves facility, special high-voltage substation, and plant electric facility at the water-conveyance and distribution control room of the No. 3 distributing pump station.

2. OUTLINE OF FACILITY

The water-conveyance and distribution facility is outlined below (*Table 1*).

Table 1 Outline of facility

Site	1-1 Kanamachi Filtration Plant, Katsushika-ku, Tokyo	
Planned supply population		3,100,000 persons
Supply capacity		1,820,000 m³/d
Service and distributing pumps	No.3 distributing pump	970 kW x 6 1,430 kW x 2
	No.4 distributing pump	2,200 kW x 5
	No.5 distributing pump	2,200 kW x 4
Clean water reservoir		9, total effective capacity 286,800 m³

3. SYSTEM CONFIGURATION AND FUNCTIONS

A block diagram of this system is shown in *Fig. 1*. An overall view of the water-conveyance and distribution control room is shown in *Fig. 2*. This system consists of a data processing system, supervisory control facility, SQC controllers for pump control, plant intercommunication system, etc.

The data processing system is a load-sharing duplex system using two computers. Its functions are divided into man-machine system and data processing system. Data transmission with the SQC controller of each site is performed by dataway transmitting unit installed at each facility. The processing functions are mainly process measurement and status and alarm supervision, automatic generation of daily, monthly, and yearly reports, setting to the site pressure controller based on water distribution pressure scheduling, and operation support of pumps by high efficiency operation guidance of service pumps.

The supervisory control system consists of two CRTs, a water distribution operation console, and graphic supervision panel. The facility is supervised and controlled from the CRTs by light pen and keyboard. The substation circuit breakers, service pumps, and other main machines are manually operated and the pump speed and pressure setting are adjusted from the water distribution operation console. A simple graphic diagram of the substation and various indicators are installed at the supervision section for more convenient operation. At the graphic supervision panel, indicators, numerical displays and status indicator lamps for the main equipment are installed on plant internal power receiving and transforming system and water-conveyance and distribution system graphics so that the entire power receiving and transforming facility and water-conveyance and distribution facility can be supervised. Operation console and supervision panel signal interface and display control are performed by supervisory control SQC controllers and auxiliary relay panels installed by facility or system.

Each site consists of an SQC controller and site supervisory control panel so that supervisory control can be performed at the site even if disconnected from the central supervisory control facility.

An SQC controller is installed for each pump. This controller has functions for operation control, speed control, operation mode selection, and data transmission with a higher level system.

Fig. 1 System block diagram

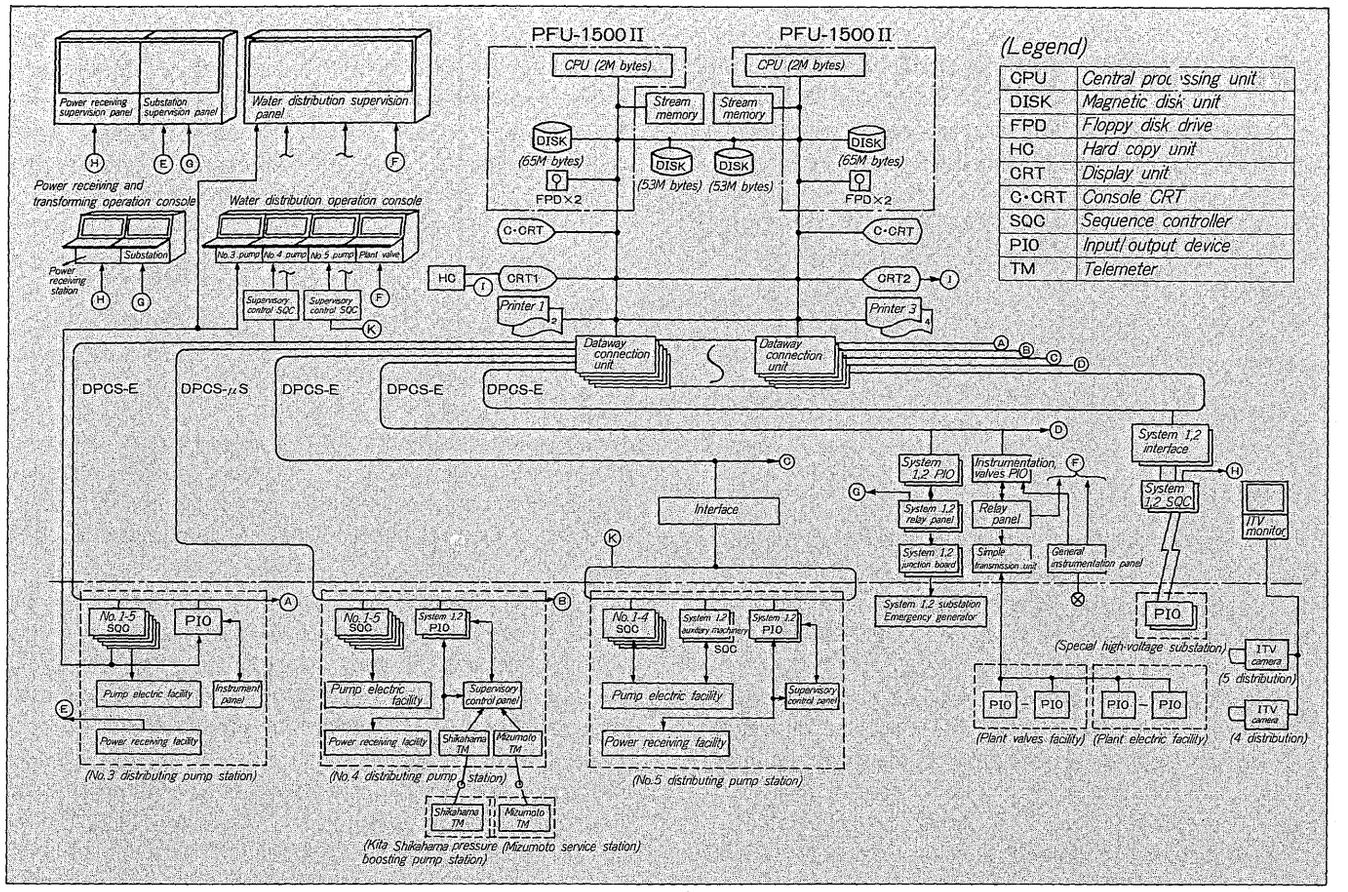
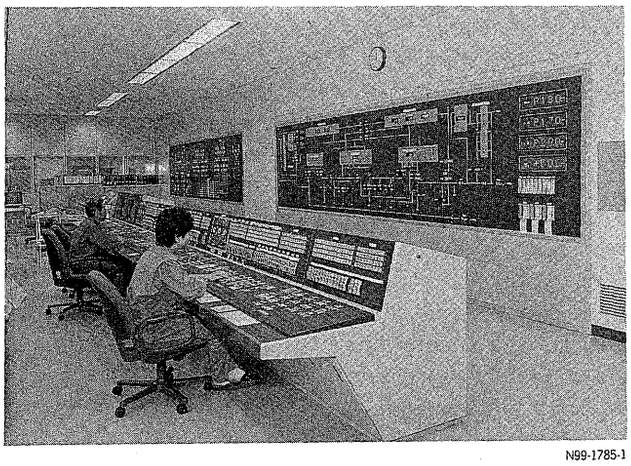


Fig. 2 Water-conveyance and distribution control room



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Plant intercommunication uses a dataway system, simple transmission system, and direct system, depending on the number of transmission points and the transmission distance. Medium distance distributing pump stations with many transmission points use the dataway system, plants with few transmission points and long distance plant electrical facility and plant valves facility use the simple transmission system, and short distance substations and common plant general instrumentation (water level, pressure, flow) with a medium number of transmission points use the direct system.

4. SYSTEM FEATURES

The main features of this system are described below.

4.1 Higher reliability data transmission

Regarding the data transmission system, which is an important point from the standpoint of building a system, high reliability was planned for the following two points:

(1) Partitioning of dataway

Dataway transmission reliability was increased by using an N:N transmission system that does not require a master station. A system in which SQC controller modernization works for each pump station and is independent for each pump station, including the supervision panel and operation panel and is connected directly was obtained by partitioning the dataway transmission line by facility. By partitioning the transmission units and transmission line, data transmission of other facilities is not affected even if a transmission unit fails or a transmission line is broken and, thus, the system is very reliable.

(2) Use of direct system

Plant general instrumentation signals must be supervised precisely at the water-conveyance and distribution

control room by measurement signals common to water-conveyance and distribution facilities. Consequently, the distributing reservoir and pump well water level, distributing water pressure, and other signals corresponding to this are sent directly from the site to the center and response is fast.

4.2 Distribution of site SQC controllers

Since operation of each pump is controlled independently by distributed installation of the SQC controllers of each electric room of the No. 3, No. 4, and No. 5 pump stations, facility expansion and renovations can be dealt with easily. Moreover, a relay-less system is realized by incorporating all the pump single and linked circuits in the SQC controller.

4.3 Efficient pump operation by computer

The distributing pumps are operated economically by using number of units control and speed control. The contents are described below.

(1) Speed control

Pump speed is controlled in accordance with a pressure setting program pattern stored in a computer in advance by a single loop controller installed at each site supervisory control panel. Six different program patterns are provided by water-conveyance and distribution system. Each pattern sequentially displays the set value for 48 points (1 day) on a CRT screen every 30 minutes, starting from 10 P.M. The contents set at the CRT are transmitted to the PIO unit installed at the site via a dataway and are set at the single loop controller by its output.

(2) Number of units control

From the standpoint of power-saving, the number of pumps with the lowest power consumption within the number of pumps that can be operated consistent with the flow and head during current operation should be operated. This is made the pump operating index and guidance is given to the operator by displaying an operation guidance screen for each pressure control block of each distributing pump station. The pump switching curve, current operating points, pump operation status, and number of efficient operation units are displayed on the operation guidance screen. Number of units switching command is performed by operator judgment based on the operation guide.

4.4 Use of FAINS-1000 series

The FAINS-1000 series is a consolidated management system concentrating the latest computer technology and water and sewage treatment technology cultivated from Fuji Electric's long experience.

Three types, FAINS-1000, 2000, and 3000, can be selected from the FAINS-1000 series to match scale and functions of the facility.

With this system, the following advantages were obtained by using the FAINS-2000:

(1) High reliability

The reliability of the software was improved by using proven packaged software.

(2) Completion of man-machine function and easy software modification

Supervisory operation was improved by placing a CRT display at the center and using a light pen and keyboard. Moreover, since modification of the software, for example, modification of the display items and printing items, by which the daily operator performs repair work addition, etc. can be performed conversationally with the CRT without a knowledge of software, changes can be made easily, even by the customer.

(3) System that can meet the delivery date

Since the basic part of the software is packaged, the demanded functions can be implemented and the software preparation time can be shortened substantially by only incorporating these packages into the application program.

Further, in-house testing can also be performed efficiently and on-site modification work can be reduced.

5. CONCLUSION

The Kanamachi filtration plant pump station supervisory control system was introduced above. Currently, each distributing pump is operating satisfactorily and an efficient operation management and highly reliable supervisory control system that was the initial purpose was realized.