ELECTRIC & INSTRUMENTATION SYSTEM FOR SHINKOIWA PUMP-STATION, SEWERAGE BUREAU, TOKYO METROPOLITAN GOVERNMENT

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1. FOREWORD

The Shinkoiwa pump-station is designed to drain the waste water and rainwater of the region south of the Nakagawa River in Katushika Ward, Tokyo and started operating in 1982. Urbanization of the drainage region of this pump station has progressed noticeably and the pump station plays an important role in preventing city type flooding. Therefore, fast and positive operation of the rainwater pumps and positive starting of the emergency power generation facility in an emergency are demanded. Daily maintenance management of the power generator and positive operation of the pumps during rainfall are important topics for the pump station operators. For this reason, high pump station operation reliability was planned by introducing an information processing system into the electric instrumentation system of this pump station for operator operation and management support.

2. OUTLINE OF FACILITY

The Shinkoiwa pump-station pump facility is outlined in *Table 1.*

Table 1 Outline of pump facility (overall plan)

Item \ Class		Waste water facility	Rainwater facility
Sand basin facility	Entrance gate	Oil hydraulic 4 gates	Oil hydraulic 7 gates
	Sand basin	4	7
	Bucket corrector	4	Running bucket elevator 1
	Screen	4	14
	Sand conveyer	1 set	
	Screening conveyer	1 set	
Pump facility	Type	Vertical shaft centrifugal mixed flow pump	Vertical shaft mixed flow pump
	Number of units, ratings	2 (500ϕ x 31m^3/min x 13.5m) 3 (900ϕ x 96m^3/min x 15m 320kW)	2 (1,350ϕ x 250m^3/min x 15m) 5 (1,650ϕ x 375m^3/min x 15m 1,250kW)

3. SYSTEM COMPOSITION AND FUNCTIONS

3.1 Power receiving and distributing facility

The power receiving and distributing facility is outlined in *Table 2.* The power receiving system is one circuit consisting of an emergency power generation facility and a facility centered about rainwater drainage. From the standpoints of reliability and energy saving, the main transformer has a capacity which equally distributed the load capacity.

3.2 Emergency power generation facility

The emergency power generation facility has two 6,500kVA diesel generators that can supply power to all the loads during a power interruption. A 5,200kW water resistance load is also installed. This load is used as an automatic system which prevents long-term operation at low load an emergency, as well as in daily test operation. To amply display the emergency functions, reliability was improved by introducing the power generation facility data management system described later.

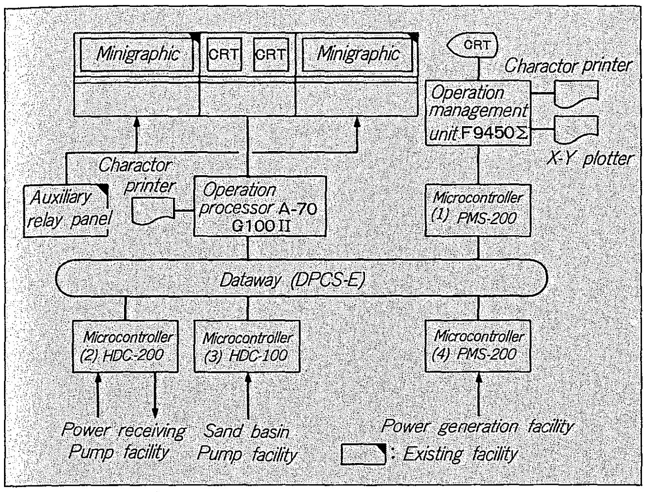
3.3 Supervisory control system

The system block diagram is shown in *Fig. 1.* This system consists of four microcontrollers, an operation

Table 2 Outline of power receiving and distributing facility

Power receiving facility	Power receiving voltage	66kV 1 circuit
	Power receiving facility	3-phase encapsulated SF_6 switchgear
	Main transformer	3ϕ 7,500kVA x 2 (oil type)
High voltage power distributing facility	Power distributing voltage	6.3kV
	Bus system	Double bus system (mains, generator)
	Station transformer	3ϕ 750kVA x 2 (oil filled) 1ϕ 150kVA x 1 (oil filled)
	High voltage distribution panel	27 (overall plan)

Fig. 1 Supervisory control system block diagram



processor and an operation management unit. Each device is connected by a dataway.

The operation processor collects the data from the microprocessors and performs various operations (simulation, others) for facility supervisory information CRT display and printing and operator support.

To process a large volume of data, a 32-bit superminicomputer (A-70) was used.

The operation management unit is used in preparing daily, monthly, and other reports and generating power generator operation supervision data. A personal computer (F9450Σ) is used. General business processing, document preparation, drawing, etc. using general purpose software are also possible.

The microcontrollers share the functions for each device. Units suited to the processing contents and data volume (HDC-100/200, PMS-200) were used. Microcontroller (1) is a buffer which performs operation management unit dataway interfacing and temporary data processing. This eliminates the need for the operation management unit to be online at all times and general business processing can be performed at an arbitrary time.

4. SYSTEM FEATURES

The features of this system are described below.

4.1 Distributed functions system

By allocating the main supervision and operation functions to the minigraphic desk and the facility detailed supervision and operation support functions to the opration processor and the daily and monthly report and other maintenance management functions to the operation management unit, each unit can be operated efficiently.

To prepare for device trouble, the operation processor and operation management unit are completely independent. On the other hand, reliability is improved by providing the minimum back-up functions.

4.2 CRT display emphasizing support functions

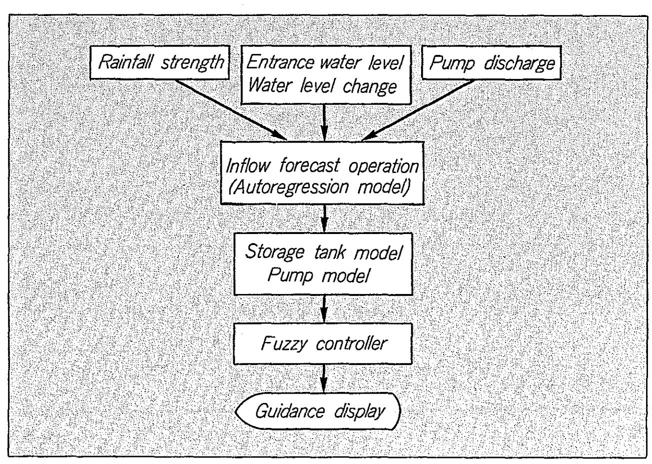
The conventional CRT display screen was mainly facility status display centered about a plant flow chart. However, with this system, the support functions described below were rounded out by the functions distribution described in paragraph 4.1.

(1) Detailed display, including the auxiliary machinery system , is performed for the power generator, waterproof doors, rainwater pump, power interruption power supply, and other important machinery and grasping of the trouble point and the range of its affect when trouble occurs is simplified.
(2) Detailed display of the rainwater pump starting conditions is performed and selection of the pump to be started and troubleshooting when the condition is not satisfied was simplified. The operating time of each part is displayed on a CRT at starting so that abnormalities can be detected quickly from the operation delay.
(3) Regarding electric power operation also, power generator addition time is supported by supervising the generator load and stabilization of rainwater pump operation, which has a large affect on the entire pump station, is supported by power receiving power demand supervision based on the pump operation forecast to be described later.

4.3 Pump operation guidance adopting fuzzy control

With this system, fuzzy control capable of automating operation near that of an experienced operation by providing control rules approaching the human senses at a computer was applied to guidance. This guidance is intended for fast support of operation relative to rainfall. As shown in the guidance procedure of *Fig. 2*, the pump starting timing is judged by fuzzy control from the rainwater inflow forecast value based on simulation and the rainfall strength, entrance water level, etc. The judgment result is displayed on a CRT in the form of a time chart based on the forecast inflow of up to 40 destinations.

Fig. 2 Pump operation guidance procedure



4.4 Generator preventive maintenance support display

Besides daily and monthly reports, the operation management unit supports improvement of maintenance management of the power generator as part of the maintenance management function. This collects and displays detailed data of each part for the power generator starting, operation, stop, and standby states. Each data can be displayed on a CRT and plotted on an X-Y plotter in the form of a graph and its characteristics can be grasped visually. Past data for an arbitrary item can be superimposed on each graph. Abnormalities can be detected in advance from changes in the generator characteristics by means of this and it is considered to display an effect in preventive maintenance.

5. CONCLUSION

The Shinkoiwa pump station electric instrumentation facility was described above centered about the supervisory control system. This system is considered to be the first step toward realization of the functions which are demanded of the electric instrumentation system of the pump stations of big cities that demand rapidity and certainty.

In the future, rounding out of functions, improvement of reliability, etc. will be undertaken in the future.