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# INTEGRATED CONTROL SYSTFM IN THE FIELD OF WATER TREATMENT PLANT

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## 1. INTRODUCTION

A water treatment plant is composed of three elements, i.e., electrical control system, instrumentation control system, instrumentation control system and data processing system. Conventionally, these systems were often planned and ordered independently to each other, and the interface portions often overlapped in the aspects of both function and equipment in the total water treatment plant system.

The electrical and instrumentation control, the plant monitoring and management functions required for the water treatment plant are arranged as a system functions schematic diagram as shown in *Fig. 1*.

## 2. APPLICATION TO WATERWORKS

### 2.1 General

Many EIC (electrical, instrumentation, computer) integrated control systems were realized in the field of waterworks. Waterworks systems are classified by scale into small scale (delivery rate around 10,000 $m^3$ per day or less), medium scale (delivery rate around 10,000-100,000 $m^3$ per

*Fig. 1* System functions schematic diagram in the field of water treatment plant

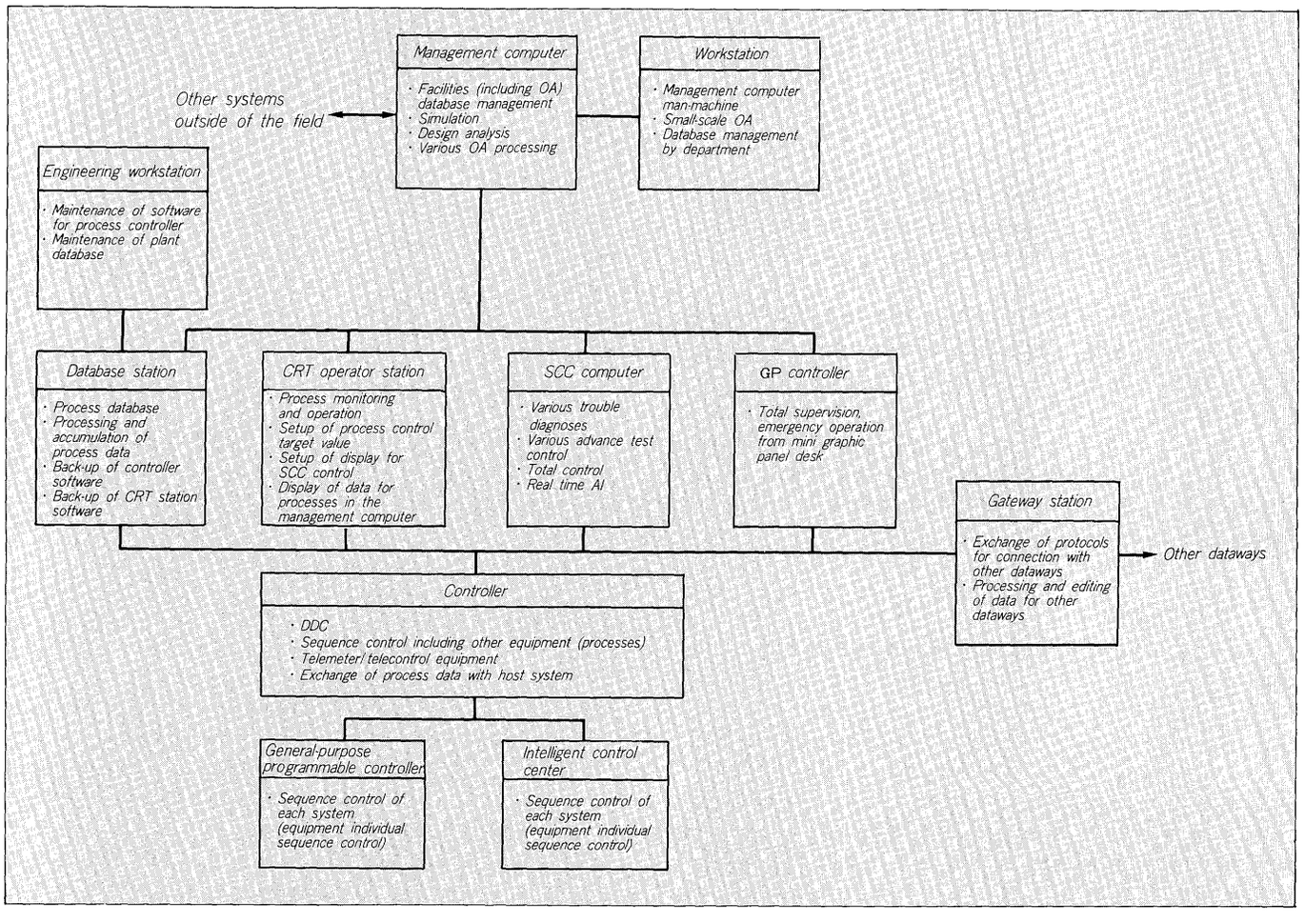
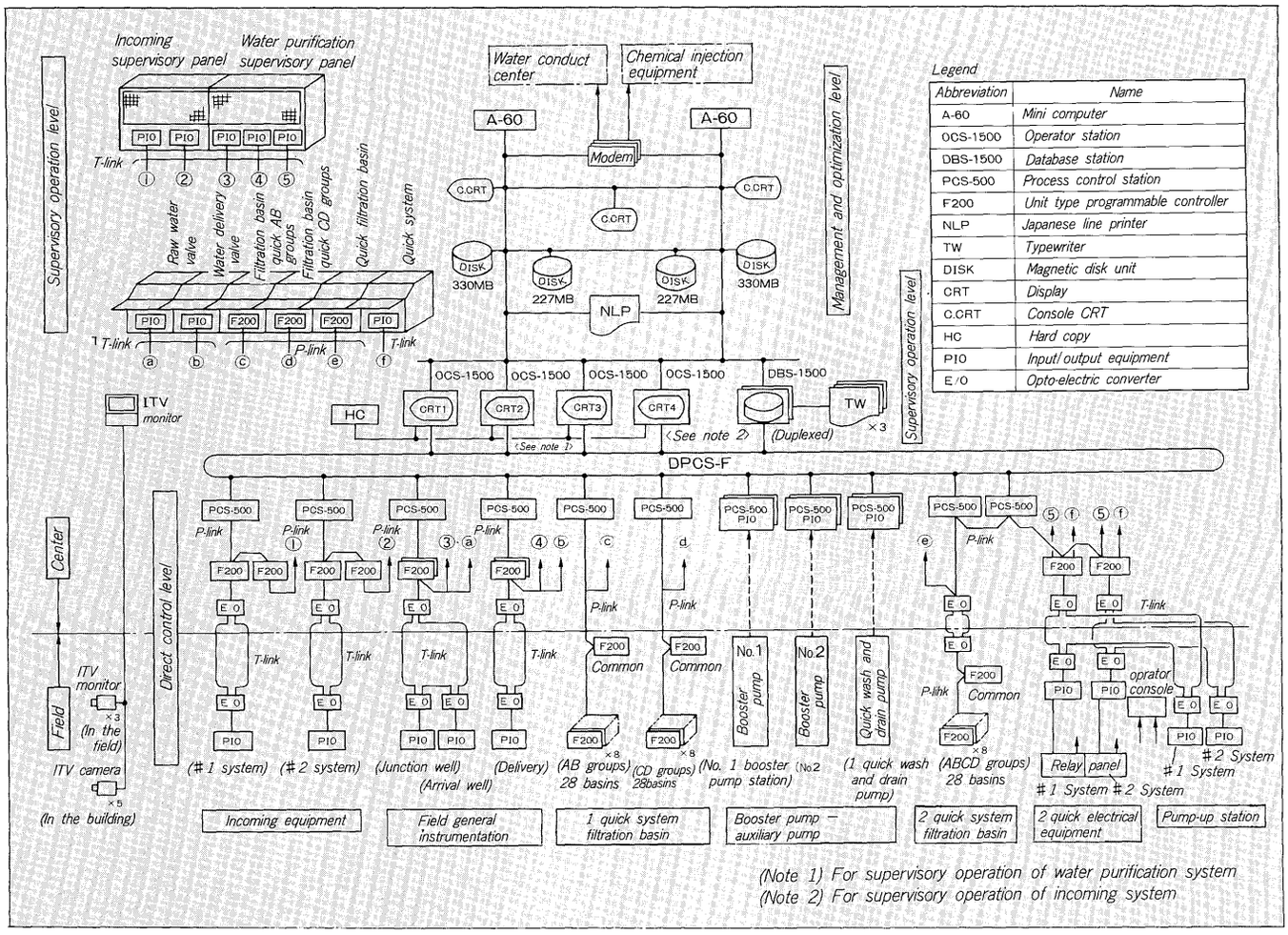


*Fig. 2* Typical implementation of integrated control system for large scale water treatment plant



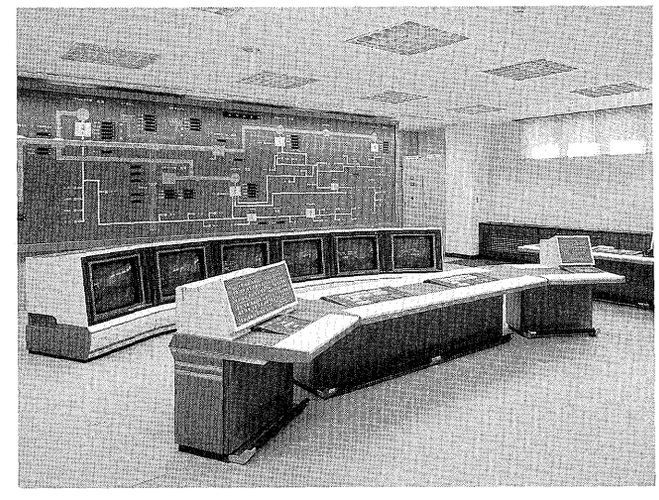

day, and large scale (delivery rate around 100,000 $m^3$ per day and up), and each integrated control system should have the configuration that corresponds to the scale of the plant.

The penetration rate of waterworks in Japan became 94.2% in fiscal 1988, and update works occupy the majority in the introduction of supervisory control system. "Flexible network configuration", which is one of concepts of integrated control systems, provides large effect in the execution of this update work. A case of implementation of update work at a large scale water treatment plant is given below as an example.

### 2.2 Typical implementation

The water treatment plant shown in *Fig. 2* is of the capacity of 1.265 million $m^3$ per day and is serving for about 2.9 million people. In the conventional system, various signals from each field were transferred to the control room through direct transfer cables, and supervisory operation was performed through large size supervisory panel equipped with controllers, indicators, recorders, etc., auxiliary relay panel and operation console. This system was entirely updated to the supervisor control system

*Fig. 3* Integrated control system control room



shown in *Fig. 2*. The new system was divided by equipment and by hierarchy, and delivered as divided into six groups in the period of four fiscal years. Division by hierarchy means that groups of the level of supervisory operation composed of supervisory panel and operation console and the group of the level of management and optimization are introduced as separate systems. Furthermore, the latter group

was also divided into two subgroups, and the redundancy system was finally constituted.

The following merits were obtained as a result of introduction of a most updated integrated control system.

(1) Ease of update work and high reliability

The feature of the new system is that various functions of the system are allocated to unit type programmable controller (PC's) in the lower level and to each component of the mini computer in the upper level, and connection is made among these components by means of a network. Accordingly, it became possible to smoothly perform the update work of the water treatment plant where it is not permitted to suspend the operation of the entire facilities at a time. In addition, the influence of equipment failure was minimized by the provision of a component for each function, and thus it has become possible to construct a highly reliable system of tough equipments.

(2) Reduction of number of transfer cables and reduction of panel installation spaces

Because of the facts that networking of equipment of unit type PC level has become possible and that processor portions and process I/O (PIO) portions of unit type PC's are installed in various fields, the copper wires cables with over 10,000 cores laid between fields and center were substituted by dozens of coaxial cables and optical fiber cables. The supervisory operation at the central control room is performed mainly with CRT's, meters and auxiliary relay panel have become unnecessary, and thus the space for installation of panels was reduced gy about 50%.

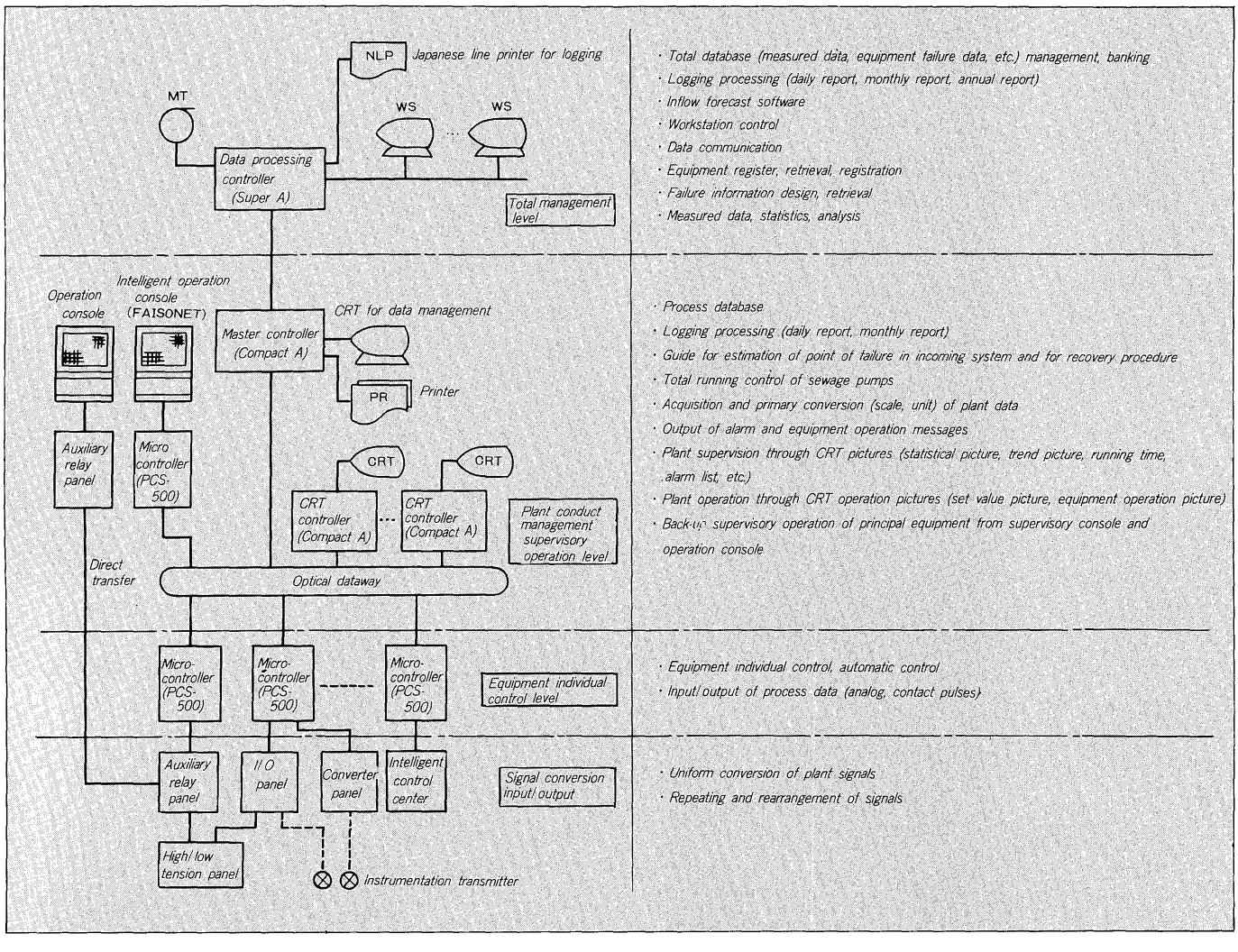
Besides the merits stated above, following fruits of most up-to-date technologies possessed by Fuji Electric Co., Ltd. are incorporated: execution of uniform intake rate running with use of water purification basin buffer by mathematical planning technique based on demand forecast, booster pump running guidance by fuzzy arithmetic operation, incoming equipment operation by CRT operation only based on the running and operation guidance, and autonomous distributed system that materializes a filtration basin control system only with unit type PC's (MICREX-F200).

A typical most updated control room is shown in *Fig. 3.*

### 2.3 Evolution in the future

The EIC integrated control system is a confirmed technology structure as a supervisory control system for

*Fig. 4* Integrated control system for large scale sewage treatment plant and its functions



waterworks processes in the field of waterworks. It is anticipated that waterworks advanced information systems composed of water conduct management system, water distribution control system and facilities information management system will make evolution in the future.

## 3. APPLICATION TO SEWAGE WORKS

### 3.1 General

The rate of penetration of sewage works facilities in Japan is still low at 40%, and construction of sewage treatment plants is being made in large scales. Distributed type integrated systems are broadly applied to medium and large scale sewage treatment plants, and they are introduced as update systems at the occasions of expansion of sewage treatment plant equipment besides the occasions of construction of new plants.

### 3.2 Typical implementation

We deliver integrated systems, which make use of mini computer devices for plant running management and supervisory operation, for large scale sewage treatment plants. A diagram that indicates the classification of system functions is shown in *Fig. 4* including a general system configuration of a general sewage treatment plant.

(1) Employment of multi-functional man-machine interface

The contents of supervision made by the operators are repleted by the employment of high resolution and multi-color CRT displays.

(2) Application of AI technology to SCC control

Sewage pump control that makes use of fuzzy control and equipment diagnosis that makes use of COMEX are materialized.

(3) Incorporation of general management operations such as OA operations

General management operations are incorporated in the system besides plant running management by the use of integrated database function and of workstations. In concrete, facilities and equipment register management, failure data management, various data statistical processing, etc. are made. Such a system configuration that incorporates limited functions by the computer for plant running management is also available.

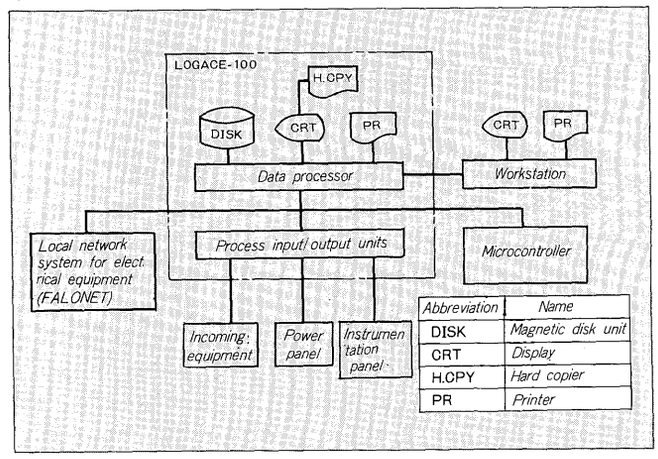
(4) Use of intelligent control center

The intelligent control center (FALONET) is adopted, and connection is made with process controllers through the direct transfer system.

### 3.3 Evolution in the future

The facilities of sewage works operations are distributed in a broad area, and the operations are implemented while the information is exchanged among them. Sewage works with advanced information systems that make use of optical communication networks are planned in the future as more significant expansion of large scale integrated systems. It is anticipated that to make contribution to increase of efficiency of business and to uplift in the quality of facilities operation and maintaining management by positively combining with rainfall, weather and river information systems and OA systems besides processing of data related to process running management with these systems will become the trend of system in the future.

*Fig. 5* Typical configuration of integrated control system for small scale facilities




## 4. SMALL SCALE SYSTEMS

The basic functions required for a small scale system are almost the same between a waterworks system and a sewage works. As the plant scale is small, the components that constitute the electrical control system and instrumentation control system are different. The equipment that bears electrical control are classified into the case where a local network system (FALONET), which was developed as a system that connects by serial transfer among electrical equipment in correspondence to the number of power load equipment and the case where a private power panel is used for covering all the equipment. At the same time, the instrumentation control equipment are also classified into the case where microcontrollers are installed depending on the number of the PID control loops and the case where a private instrumentation panel having a single loop controller as the core is installed. The data processing system makes use of LOGACE-100 system that unifys the functions of the database station and of the CRT operator station shown in *Fig. 1*. Since this system is equipped with an independent PIO unit besides the data link function, it is applicable to a system that makes use of private power panel and instrumentation panel.

It is considered that needs of advanced system functions such as demand forecast deduced frotes plant operation data and trouble diagnosis will increase in the future even for a small scale system. In such a case, it is possible to adopt such a system configuration that workstations are connected to the LOGACE-100 system through a general-purpose LAN and OA operations such as simulation, statistical analysis and rates calculation are executed on

the workstations. A typical system configuration in such a case is shown in *Fig. 5*.

## 5. AFTERWORD

Waterworks and sewage work operations are what support the basis of the social life, and more efficient management is required. For this object, such system that permit easy incorporation of fruits of new technologies as required in addition to essential system functions such as operability, supervisability, maintainability and high reliability are required. We intend to make further expansion so that integrated control systems will become able to meet such requirements.